

DIGITAL VERSION



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can infect your PC

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Welcome!



WE'RE USED TO technology dropping in price as time goes on, but some of the bargains to be had in the world of tablets

took us by surprise. Top-of-the-range models from less than a year ago can now be had for the same price as a mid-range tablet, meaning Ultra HD screens and the latest version of Android can be yours for just £250.

If you're willing to put up with a still-super-sharp Full HD display, you'll even get change from £100, and for those who must have the best, the very latest models from Microsoft and Sony really push the envelope when it comes to design. Find the perfect tablet for you in our group test, starting on page 78.

After a few years in the doldrums, Microsoft seems to be undergoing something of a

renaissance. Not only is Windows 10 shaping up to be actually rather good, but there are plenty of people excited about the new HoloLens augmented-reality headset. This is part of a growing trend where the digital world crosses paths with the physical one; we find out if the future of computing is really here on page 96.

Of course, none of these technological advances would be possible were it not for the humble computer, and a computer is just a box of plastic and metal without an operating system. You may know how to use your computer's OS, but do you know how it actually works? In our feature this month, we've explained everything, starting on page 102.

Chris Fynamore, Editor
chris@computershopper.co.uk

MEET
THE
TEAM

QUESTION OF THE MONTH

Now Windows 10 is nearly here, what will you miss most about Windows 8?



Chris Fynamore

“The excitement of playing ‘hunt the settings menu’”



David Ludlow

“Files opening in random and usually rubbish Modern apps”



Katharine Byrne

“Fighting the charmless Charms Bar for screen space every time I try to close a window”



Michael Passingham

“The heroic efforts of third-party programmers to make the interface usable”



Seth Barton

“How the whole OS was only usable thanks to the tacked-on WIN+X command”



Tom Morgan

“The blatant insult to users that was the Windows 8.1 Start button”



Richard Easton

“The incredibly longwinded process of going from a fresh Windows 8 install to Windows 8.1”

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UK £44.99, Europe £70, Rest of world £90

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Printed by Polestar, Bicester, Oxon
Distributors Seymour 020 7429 4000

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A DENNIS PUBLICATION

Computer Shopper is published by Dennis Publishing Ltd, 30 Cleveland Street, London W1T 4JD. Company registered in England. All material © Dennis Publishing Limited licensed by Felden 2015, and may not be reproduced in whole or part without the consent of the publishers. ISSN 0955-8578

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Contents



Regulares

6 Letters

10 Under Development

A nasty financial shock for **David Robinson** this month, as he finds some cyber-urchin has been fiddling with his account

12 Cybercop

There's more cybercrime about than you may think, but at least the powers that be are doing something, says **Gordon Holmes**

14 Rants & Raves

Shopper is throwing its clogs in the loom this month, as it decides books are better than Google and fitness tracking's for mugs

146 Zygote

Voter fraud makes the land of the free look like the home of the cyber-illiterate. Better to follow Australia's example and fight antisocial behaviour with Barry Manilow

News

16 Newsfile

We round up the latest technology events

Learn

130 Use Continuity with iOS 8

We explain how to make and receive phone calls on all your iOS 8 devices

132 Business Help

Our resident expert answers those persistent software queries

134 Helpfile

Step this way for all your hardware and Windows problems

136 Advanced Projects

Dropbox is already a great way to keep your files in sync, but there are several free ways to make it even more powerful and flexible. **Clive Webster** shows you how

139 Multimedia Expert

Ben Pitt shows you the magic of convolution effects, which apply the acoustics of real spaces to your sound recordings

143 App Creative

You don't need a fancy camera to make amazing light paintings. Incredible effects are possible with your tablet or smartphone, as **Ben Pitt** explains

Features

96 Virtually real

Thanks to new tech such as Microsoft's HoloLens augmented-reality headset, the digital world has never been closer to the physical. **Nicole Kobie** gazes into the future

102 OS explained

It's at the heart of everything you do with your PC, but how does the operating system work? **Mike Bedford** takes a look under the bonnet

108 Music to your ears

Established names Spotify and Napster are up against upstarts such as Tidal in the battle for your listening attention. We find out which music-streaming service is the one for you

115 Take control of your email

An email address on your own domain gives you more control over your account. We show you the benefits of leaving Gmail behind

118 A Bing in the tail

Unofficial download sites advertised on Bing can infect your PC with malware. We use our sacrificial laptop to see how bad the problem is

121 Charge faster

We investigate why modern laptops and phones can take an age to charge, and show you how to speed things up

124 Save £££s on your phone contract

Buying a phone with a contract isn't always the cheapest way. We show you how to get the phone you want at the right price



Reviews

24 This month's hot product

Apple's beautiful new MacBook is the first laptop we've seen with the multipurpose USB Type-C port



26 PCs & Laptops

With space for three hard disks in a chassis smaller than a pint glass, Acer's Revo One is our new favourite mini-PC

32 Handhelds

LG isn't afraid to incur the wrath of PETA with the G4 – its new flagship smartphone is made using real leather

36 Photography

You don't need to buy a full-frame DSLR to get top-end features, as Nikon proves with the excellent D7200

39 Displays

Looking for a monitor for your games console? BenQ's RL2755HM was built specifically with gamers in mind

42 Home Cinema

With a gorgeous 4K panel plus a comprehensive WebOS smart TV system, LG's 60UF850V is a superb – if expensive – top-end TV

47 Audio

A USB sound card, DAC and headphone amp all in one tiny box – the Sound Blaster E5 is as flexible as audio kit gets

48 Video

Amazon's Fire TV Stick is a media streamer and TV dongle that even lets you play games

52 Printers & Scanners

It's a four-way inkjet MFP shoot-out this month

54 Networks

BT's 802.11ac wireless range extender can eliminate troublesome Wi-Fi dead spots

56 Storage

HGST's latest Deskstar hard disks are optimised for NAS drives

56 Components

The Pipsta adds printing to a £30 Raspberry Pi

59 Software

Adobe's latest update to Lightroom improves on an already impeccable photography tool

60 Games

Put the pedal to the metal with Project CARS

64 Best Buys

The best kit we've reviewed recently

72 How We Test

Our comprehensive tests and ratings explained

Group Test

78 Tablets

From the latest iPads to Microsoft's new Surface and all the best Android models, there's a tablet for you in this month's group test. And with prices as low as £80, there's a slate here for everyone



74 Your software*

Clear out the clutter and tune up your PC with this comprehensive yet easy-to-use suite of optimisation tools for Windows.

6 FULL PACKAGES



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Letters

We're only human – all of us – and when we're not dropping our phones or inviting adware on to our PCs, we're ignoring the small print and making mathematical errors measured in the gazillions, as our mailbag attests

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OPEN TO ATTACK

✉ Before typing this I read an interesting – but to me obvious – article about Wi-Fi security in hotels. Some hotels provide encryption codes specific to your room, some give a general encryption code and others use open Wi-Fi.

I've tried to explain this to others, who don't understand that having an unencrypted connection is like leaving your front door open. If you can get on to someone's network, for example, you can see what devices are connected. Anyone who then connects to your network can try to access your computers, and if those computers have no passwords, the intruder will have access to your data and can install software on your computer such as a keylogger.

Many users are happy to have unencrypted Wi-Fi networks with standard passwords for their router, no passwords for their computer logins or easily guessed passwords, and yet they would never leave their front door open. While they understand that someone gaining physical access to your home could take all your possessions, they don't seem to see that someone can take all your data over Wi-Fi because it isn't a physical connection or presence. How do we protect ourselves when forced to use an unencrypted network such as at a hotel?

Paul Winstone

Using an open network isn't the most secure way of getting online, but it depends on the kind of network you're connecting to. If an open 'Guest' network has been set up correctly, computers will connect to it in wireless isolation mode, in which connected PCs can't see each other. This still isn't as secure as using an encrypted connection, but it means no-one will be able to jump in and see your files.

If you're worried about connecting to wireless hotspots in hotels, make sure your anti-virus software is up to date, check that your Windows account has a password and, once you've connected to a hotspot, check the Network section in Windows' File

Explorer. If you can see other computers in there, it's probably best to disconnect.

WALL WART CURE

✉ I was reading 'Shocking story' (*Letters, Shopper 327*), in which Trevor Wainwright was bemoaning issues he'd had with USB plugs to charge his devices. My wife and I always used to fight over an easily accessible plug point in our living room. Chargers were often unplugged for other items (iron, vacuum cleaner and so on) and then not put back, causing phones to run out of charge.

The solution was surprisingly simple: a socket with built-in USB points. With this arrangement we can have two devices charging while using the socket for other things. Once you've installed one, you'll wonder why you don't have them all over the house. We've now have three of them!

Grant Wilson

Now that more of our devices charge using a USB connection, it certainly makes sense to have USB plugs built into your wall sockets. Bear in mind, however, that USB charging specifications change. For example, phone chargers used to draw 1A, but many modern smartphone and tablet chargers are now rated for 2A of current, and it's easier to upgrade a wall charger than an entire socket.



Solve power struggles with a USB wall socket



Open Wi-Fi networks are not the most secure type of internet access

CASE IN POINT

✉ In your review of the Samsung Galaxy S6 and S6 Edge (*Reviews, Shopper 329*) you say you prefer the Edge to the standard S6 "which constantly felt like it was about to fly out of our hand". Then in the review of the new HTC One M9 you refer to the M8, "which constantly felt like we were about to drop it".

Last Christmas I bought the gorgeous LG G3 with its incredibly smooth back. When I showed it around my extended family, three people dug out smartphones with smashed displays – a result of phones being dropped. I was urged to get a strong case immediately.

I tried three before I found one that looked as if it might provide suitable protection. And after twice dropping the phone enclosed in its case, I'm mighty glad of the advice. The leather case I settled on also prevents scratches from coins and car keys when the phone is in my pocket.


The case has brought another problem to light, however – the inductive charger I bought with the LG G3 now barely charges the phone (the replacement LG G3 inductive case you can buy is laughable and would provide no protection from a drop to the pavement). I have had to revert to cable-charging. It's time smartphone designers designed for the real world and started to sell their phones with suitable protective cases.

Jim Woods

As smartphones have got ever bigger, they've also become trickier to keep hold of, especially when using them one-handed. The

★ Star letter

HOW PCs DON'T WORK

 I was very interested in the article 'How Processors Really Work' in *Shopper 329*, and especially how it's possible to build a simulated machine in Minecraft. Unfortunately, although the description of a D-Type Latch in the article was well explained, the logic diagram at the top of page 99 was wrong. The device shown in the diagram wouldn't work as described and would transfer whatever was on the Data input to the Q output whenever the clock was at a 1, and not just on the transition from 0 to 1. The latch in the diagram passes the D input to the Q output whenever the clock is 1, and latches the current state of D as the clock switches from 1 to 0. The circuit that should have appeared is pictured here (right). This picture was taken from Wikipedia, and performs as described in the text of the article.

The proper circuit consists of three bistable circuits – two for input and one for output. When the clock is a zero, the input bistables are in a state where they cannot latch in a specific state and they will attempt to change as the data input

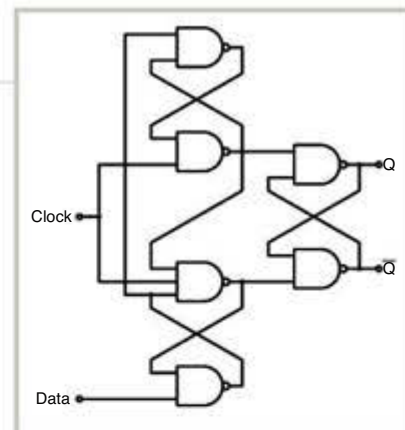
changes. At the same time, their output to the output stage is forced to a high state on both the inputs to the output bistable, which continues to store its previous contents. When the clock goes to a one, the input bistables capture their current input states, and because of the cross coupling between the two input bistables, their outputs to the output stage remain fixed. At this point, the output stage takes the value of the data input as the clock changed state. Some devices have two more inputs (Set and Clear) to force the latch into a specific state when these inputs are in a specific state. These inputs work whenever they are in their operating level and not on the transition.

The diagram in *Shopper 329* is a level-triggered device, while the diagram here is an edge-triggered device.

Richard Taylor

Thank you for your detailed correction. Mike Bedford, the feature's author, replies:

"We're pleased that you found the article interesting. Strictly speaking, what you say is absolutely correct – the D-type latch we provided is level triggered rather than edge




▲ A logic diagram for an edge-triggered D-type Latch

triggered. However, the only circumstance in which it would behave differently to our description is if the input data changed while the clock was high. The circuit you provided is better in that it overcomes this difficulty with the basic D-type latch and will, indeed, be the preferred variant in many applications. However, given our aim of opening up what many people had considered impenetrable, we trust that you'll excuse us in painting as simple a picture as possible, even if it involved glossing over some of the finer points."

huge LG G3, with its slippery back, is quite one for taking a leap of faith on to the pavement.

One of our favourite cases, which did a good job of protecting the handset without compromising its functions, was the 'bumper' for the Apple iPhone 4. It also happened to be an essential purchase because of that particular iPhone's habit of shattering into a thousand pieces if you looked at it funnily.

LEGAL EASE

 In *Cybercop*, *Shopper 324*, Gordon Holmes advised us to check the small print in the context of the permissions that apps want us to agree to. That makes good sense, but isn't there a limit to reading small print for any reasonable human being?

I just received an email from PayPal about the company's separation from eBay, with no explanations but a link to 'policy updates'. These 'updates' run to about 10,000 words, which would take, at average reading speed, about 50 minutes to digest. PayPal has 162 million customers. If we all read the updates we will, together, be wasting over 15,000 years of our time. And we will probably fail to notice any changes we actually care about, having long since lost the will to live.


Sadly, unlike the lawyers who inflict this stifled prose upon us, we will not be rewarded for the time we have lost. Surely there must be a better way?

David Faulkner

There may be some important information buried in the PayPal update, but we'll bet that few people will actually bother to find it. Another examples of spurious legalese is the end-user licence agreement (EULA) you need to agree to before you install pretty much any software or game. These can run to thousands of words, and we have yet to meet anyone who actually reads them in their entirety.

This, of course, defeats the object, but there are moves from some companies to improve the EULA. For example, *The Witcher 3: Wild Hunt* (see page 62) has a mere 693-word licence agreement, written in plain English, which most players will probably read in its entirety. Compare this with the 6,349 words of garbage you have to trawl through before playing *Grand Theft Auto V*, and you'll see why things need to change.

THE INTERNET OF MASSIVE NUMBERS

 Gordon Holmes made some valid points regarding the Internet of Things (*Cybercop*, *Shopper 329*), but he underestimates the maths of IPv6. IPv4 uses 32-bit addresses to give 2^{32} or about 4,300 million addresses, which is around two per person. IPv6 uses 128-bit addresses to give 2^{128} or about 3.4×10^{38} . If this gave only 4,000 IP addresses per person, the population of the planet should be 8.5×10^{34} or 85 decillion. It's generally agreed that the world


population is less than that, at just over 7.2×10^9 or 7,200 million. It's doubtful that this planet could sustain such a population increase. Allowing for a modest 12.5% population growth, IPv6 gives 4.2×10^{28} or 42 octillion addresses per person. Even Gordon should have fewer IoT devices than that.

With enough addresses for 340 trillion per planet in the universe, it makes me wonder if the IPv6 designers know something we don't. Aliens, anyone?

Brian Hunter

As the migration from IPv4 to IPv6 is taking so long, the designers of the latest internet protocol seem to be making sure there will be enough IP addresses for the entire United Federation of Planets without having to faff around upgrading the galaxy's routers.

PRIVACY WOES

 Thanks for another great issue. In the feature 'Get More From Google' (*Shopper 329*), you made passing mention of encrypting email. I like what the good people at ProtonMail (en.wikipedia.org/wiki/ProtonMail) have done for those who want to be hyper-cautious.

On the other hand, the overheads are annoying unless your correspondent shares your wants, although you can still send encrypted ProtonMail to non-ProtonMail users. It just isn't quite as untraceable.

A more hassle-free approach is to write the message you want to send using the free OpenOffice suite. Use OpenOffice's native tools to produce a password-protected PDF, then send the PDF as an attachment to an email. Your recipient will need to know the password you've used, but there are many ways to arrange this.

Tom Boyd

Email is an insecure medium insofar as messages are stored in plain text, and if someone were to gain access to the server they could in theory read everything in your account. As you point out, there are ways to encrypt email – either using a third-party service or a plug-in for an email client such as Thunderbird. However, you then have to make sure the recipient is using the same system and has your public key, or they will receive an email full of garbage instead of text.

An encrypted PDF is a reasonable way around this, but be sure to choose a strong password – many free PDF password-cracking tools exist and can crack a simple password in seconds.

TOOLBAR TRUCULENCE

I was interested to read your article on removing rogue browser extensions (Shopper 329). I've had several problems with these over the years, as I'm sure most readers have, and they are frustrating.

I've tried many removal methods, including the IE Tools. Unfortunately, the Toolbars and Extensions status is often greyed out, making it impossible to disable these obstinate programs. The only way to remove them is to access the Registry in Safe mode and delete files. This was the only way of removing annoying shopping ads that came with a piece of software I installed recently. They hadn't been mentioned in the setup, and neither Kaspersky 2015 nor Toolbar Terminator picked them up.

So if you want to get to grips with these nasties, you have to roll up your sleeves, identify

the files, delete them in Safe mode and use RegEdit. Scary stuff, I'm afraid!

Pete Clough

The longer those toolbars sit on people's PCs, the more money the scammers make, so it stands to reason they'd make them difficult to remove. Prevention is better than cure, so be sure you know what you're downloading and check what you're installing before you click any OK buttons.

STAYING ON TOP


The hints in 'How to... Manage your desktop windows more efficiently' (Shopper 329) are helpful, but such dodges wouldn't be necessary if Windows didn't insist on bringing a window to the front as soon as you do anything in it. Of course there are times when you do need the whole of a window to be visible, but very often you don't.

In RISC OS you can work with overlapping windows. You can bring one to the front if and when you need to and, likewise, push it to the back, but if you need to expose only a bit of it (to copy and paste some text, for example) you can do that without the window jumping to the front and covering up something else, such as the window you want to paste into. Is there any add-on for Windows to allow this behaviour?

Richard Mellish

This particular Windows annoyance can be fixed with an Autohotkey script. Download Autohotkey from www.autohotkey.com, and edit the default script (which should be sitting in your notification area). Add the following line to the script:

```
f7:: Winset, Alwaysontop, , A
```

Now when you want a window to stay on top, just select it and press F7. Press F7 again to cancel. You can replace F7 with whatever key or combination you like. 

WRITE IN AND WIN

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Give **David Robinson** some credit – he always pays his bills on time, so it was a surprise when his bank card was declined. Sadly, it was only the start of his problems



DAVID ROBINSON
Software and systems developer
letters@computershopper.co.uk

“THAT’S £20, PLEASE,” said the shop assistant. My Visa card went into the machine. I entered the PIN and the machine said “transaction denied”. I must be getting clumsy in my old age, I thought, and tried again. Same result. “Sometimes it plays up,” said the assistant. I tried another card and it worked just fine. Not the machine, then.

I met Mrs R outside the shop and we went to eat. Out came the Visa card and in went the PIN – very carefully this time. “Transaction denied,” said the machine. Uh-oh. Then a text arrived from the card company asking me to call customer services. So I did, only to be told that I can’t call the number from a mobile. Argh!

This helpful information was followed by three texts. Two told me what I already knew – that my card had been denied twice. The third asked me to confirm that three recent transactions had been initiated by me. Two had but the third had not.

I drove home and tried to log into the card account. Security there is the usual username, which is unique to the account, and a passcode, which is numeric and not used on any other site.

Why do they even allow people to change their date of birth? It’s not as if it’s on a different date each year

Finally you have to provide two letters from a “memorable word”. All this means the login details aren’t easy for an interloper to guess. The site’s response? “Bog off!” Well, it didn’t actually say that, but that’s what it meant. I phoned customer services – on a landline – and was asked for my card number and date of birth.

Next followed five minutes of verbal gymnastics as I negotiated with a voice-recognition menu

system. “Why are you calling?” “Card denied.” “Your call matters to us,” said the infuriatingly serene robot woman, “please say that again.” She’s worse than the one living in my satnav.

Eventually I managed to speak to a human being. I asked why transactions were being refused, and he quoted the text I received, saying that a transaction hadn’t been initiated by me. He then asked when I’d last logged into the account-management website. The answer was once, successfully, two weeks before to check the balance, plus one unsuccessful attempt today. He then informed me that someone had tried to log into the account and change my date of birth. What? Tried? Either they logged in or they didn’t. And if they didn’t, how could they try to change my DOB? And why do you even allow people to change their DOB? It’s not as if it’s on a different date each year.

DEVIL IN THE DETAILS


This raised a host of questions that the customer service person couldn’t answer but, principally, how did the miscreant get my login details? I’m running Windows Defender with fully up-to-date definitions for virus protection, as well as Malwarebytes Professional for dealing with malware. Neither showed anything that would allow the type of key-logging activity that would relay my authentication codes to a criminal. I also have IBM Trusteer Rapport installed, which looks for phishing and key-logging activity in real time. This came free from my bank, which won’t accept any responsibility for online fraud unless you have it running.

All three defences were running properly and a Malwarebytes manual scan came up negative. I can’t think where else the details could have come from. Even though it’s convenient to have my browser

recall logins and passwords, I never store details of financially related logins on the computer, not even in an encrypted form. The login details contain no information (such as the credit card number, expiry date or CVC number) that might have been fished out of somewhere else such as an Amazon account – so how did anyone get as far as being able to change my DOB? How did they get the card number, expiry date and CVC to make a purchase? The man on the end of the line has no answer.

CANCEL FOR DEFENCE

The remedy is to cancel the card, close the account and issue another one on a new account. The man pushes the button. Five days later I get a new card, then wait 10 more days for the PIN to arrive. How they can manufacture a card imprinted with unique information in five days but take 15 days to generate and send a four-digit number is beyond me. It’s beyond customer services, too.

It was my birthday last week and I received many greetings from fellow Facebook users, which was very gratifying. One was from old friend William (Bill) Poel, who’s a former *Shopper* contributor and was a leading light in Lord Sugar’s venture into personal computers. Bill castigated me for storing my real birthday in my Facebook details. And he has a point, especially as my credit card company asked for my DOB when I tried to access its services. I could change the Facebook details but, apart from the dubious wisdom of shutting the door after the horse has bolted, I’d wind up getting a slew of greetings from confused friends who were convinced my birthday was at the beginning not the end of the year. Perhaps I should be like the Queen and have two birthdays – for security reasons, of course. Be careful out there. 



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Joined-up thinking

The true figures for cybercrime are much higher than those reported. However, as **Gordon Holmes** explains, agencies are starting to work together to beat the baddies



GORDON HOLMES

With more than 30 years of experience in law enforcement, our retired cop gives a police officer's perspective on the sticky subject of cybercrime
letters@computershopper.co.uk

IN THE LIGHT of my experience of working with both the Met and the City of London police forces in the areas of fraud and cybercrime, it was interesting to read the comments of City Commissioner Adrian Leppard at a recent TechUK conference.

Leppard told his audience that UK banks aren't admitting the scale of the cyberattacks on their systems, reporting only one in five online crimes, and only one in five of these reported crimes receiving a proper response from law-enforcement agencies.

His comments are backed up by Dr Richard Clayton, a security researcher at Cambridge University. He told the Treasury Select Committee in November last year: "Insiders tell me the going rate is about twice the amount of money [reported by banks] goes walkies out of people's accounts", and banks keep this figure secret because a lot of it is recovered.

I first met Clayton on a course at which he gave an intense and fast-paced lecture on the technicalities of the TCP/IP protocol. My head was spinning for two hours afterwards. There

credit card industry, has issued figures showing that online crime increased by 48% in 2014, with the bad guys stealing more than £60m in 53,192 incidents. These 'incidents' refer to individuals and businesses whose machines have been compromised and who have had money stolen.

Both men talk of attacks on banks when, in fact, the attacks are against the customers who use those banks' online services. It is customers' money that criminals want, and it is generally customers' machines that they aim to compromise.

Regular readers will know I have a particularly large bee in my bonnet when it comes to banks letting their customers know if the device they use to connect to their online banking service is riddled with malware. Presently, banks don't pass this info on, and I think it's about time they did.

When headlines say banks are being attacked and money stolen, people may think the banks are a bunch of robbing so-and-sos themselves and probably deserve what they get. They might be more forgiving if the emphasis was on families and small businesses being surreptitiously relieved of their cash.

FIGHTING BACK

The good news is that despite the worrying statistics above, the bad guys are not getting things all their own way. Although online banking crime incidents are up, a lot of work is being done to redress the balance.

In March, the National Cyber Crime Unit (NCCU) – a division of the National Crime Agency working in partnership with the FBI, the Met's Operation Falcon, Police Scotland and a network of Regional Organised Crime Units (ROCU) – hit the streets in a coordinated week-long cybercrime operation.

The figures and scope of offences under investigation are impressive. There were a total of

25 operations undertaken in a week, resulting in arrests for network intrusion and data theft from multinational companies and government agencies.

More arrests were made for the launching of distributed denial of service (DDoS) attacks, cyberfraud and malware distribution and development. A total of 57 people were arrested, making a huge dent in some pretty sophisticated organised crime groups.

ARRESTED DEVELOPMENT

A 21-year-old man was arrested on suspicion of a network-intrusion attack by the 'D33Ds Company' hacking group, which stole over 400,000 email addresses and passwords from Yahoo! and published them online in 2012.

A 23-year-old man was arrested by NCCU officers, supported by West Midlands ROCU, on suspicion of offences relating to a network intrusion in June 2014 at the US Department of Defense (DoD). This relates to the theft of information from the Enhanced Mobile Satellite Services global communication system used by the DoD to communicate with employees internationally.

The initiative didn't just end there. Investigators visited approximately 60 businesses with personalised security data reports in hand, identifying 5,531 compromises on servers within the UK. These compromises could have been used to send out spam email, launch attacks against websites or servers, or install phishing websites to gain access to sensitive information.

These are great examples of working to remove the causes of compromise as well as rounding up the cybercriminals responsible. It's beyond me why this series of operations didn't receive the publicity it deserved, but I do know there's a head of steam building for the next joint op. Watch this space. ☒

57 people were arrested in a week-long operation, making a huge dent in some pretty sophisticated organised crime groups

is no doubt he has a good grasp of the methods used by online criminals and that his sources, the "insiders" mentioned in his evidence to the select committee, keep him fully informed.

FOCUS SHIFT

I have a great deal of respect for both these gentlemen, but I fear the way they phrased their concerns shifts the focus of attention from where it should be.

Financial Fraud Action (FFA), which represents the banking and

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Unleash The Power

RANTS & RAVES

Our intrepid explorers find that a guidebook is much more reliable than Google when you're in foreign climes – just don't expect us to monitor our fitness while we're there



Mel Croucher

RANTS

A relationship with a control freak can soon turn sour, unless you're the neurotic and gullible type

I WOKE UP with him on Sunday morning. He's in a band, his name is Surge, he is sleek and black, and he only charges two hundred quid to take me in hand. He came with the enigmatic instruction, "Give your wrist a rest by taking the band off every now and then. If the band gets wet or if you sweat in it, completely dry the band before putting it back on." How very wise.

Surge is the brand name of one of those wearable health apps on a band, designed to develop a special relationship between me, my guilt and my bank balance. With the Apple Watch being touted as a fitness essential at a much higher price, I decided to get ahead of the game and embrace this life-affirming technology on the cheap. On Monday the first doubts set in.

Surge kept telling me my heart rate increased when I was active, and decreased when I was not. Actually, I sort of knew that already. Surge also developed the irritating habit of tracking me by GPS, telling me

what route I had just slouched, how long it had taken, and how far above sea level I was. And to think, before I met Surge I had to work out these things by myself using what is technically known as 'my short-term memory' and 'my eyes'. By Tuesday, Surge was getting cocky, and insisted on comparing today's activities with yesterday's, throwing in the number of calories I was burning and the number of floors I had climbed. By Wednesday he was trying to control songs from my mobile playlist.

On Thursday morning, Surge began to send me text notifications, with invitations to gain kudos and win badges by losing as much weight as I could. In the afternoon he signed me up to a global group of brand new friends, whose only common denominator seemed to be competitive anorexia. That night he woke me up every hour with a vibration alarm, to remind me that my sleep pattern was being monitored. When I surfaced on Friday morning I

discovered my electronic wristband had automatically synced with my desktop PC, and spewed out screens full of graphs, stats and health warnings. After I cleared all his crap off my desktop I checked the facts, and my worst fears were realised. Devices such as Surge, Fitbit, Gearfit, Vivosmart and the rest have absolutely no medical or scientific accreditation whatsoever. There is not a shred of evidence that they improve the health, fitness or body-mass index of the wearer. In fact I reckon they are deliberately aimed at the neurotic, the worried-well, the hopelessly unfit and the gullible, who have surrendered the ability to think for themselves in favour of the continual delusion of looking at a screen instead of living life itself.

On Saturday, I gave my wrist a rest and dried the sweat off Surge. Our relationship was over, and I knew I had to dump him. That night I introduced him to someone I didn't like and slipped him on their wrist.



Michael Passingham

RANTS

Online maps are brilliant when they work, but a jaunt to Italy reveals that they can also leave you (Venetian) blind

IT'S BEEN A long time since I took a foreign holiday. My most recent trips abroad in the last two years have been entirely for work purposes, with some anonymous agency arranging my flights, transfers, hotels and meals. As a result, my experience with Google Maps has been almost entirely limited to the UK, which as a country is generally very well Google-indexed.

As a result, if a place exists, I'm used to being able to find it on my phone. What I didn't realise is that Blighty has spoilt me rotten. This became clear as soon as I got off the plane in Venice. Nearly 10 million people visit the city of canals each year, which makes it one of Europe's most popular tourist destinations. You'd think, therefore, that the likes of Google would have its spiders in all the city's shops,

restaurants, tourist traps and water buses. Heck, they've even taken a Gondola through every waterway and uploaded it to Google Street View.

Primed with a 4G roaming package and 5GB of data to burn through, my travelling companion and I arrived with high hopes of getting the ultimate digitally assisted Venetian experience. We figured we'd be able to improvise while we were there, so we didn't plan anything apart from the hotel. In retrospect, this was a terrible idea.

Things started badly. Google doesn't understand the Italian train and bus system very well, which was rather unhelpful when trying to get from A to B. It also didn't know where our hotel was. Restaurant listings, descriptions, reviews and closing times were inaccurate and out of date, too.

This came to a head when we were forced to guzzle down our Italian beers in 15 minutes rather than sip them over the hour and 15 minutes we thought we had.

It seems we're still not ready to drop the maps and guidebooks. Many local businesses, in Venice and beyond, don't have websites, which means Google can't rely on pre-existing online information. We can't believe this is something that Google, with its near-bottomless resources, is unable to fix. Surely it's not that hard to get some local feet on the ground to fill in the gaps? This is a company built on data, and humans, while imperfect, are fairly good at pottering around and gathering data no web crawler can find. I, for one, would be happy to volunteer to assist Google in its quest to keep holiday destinations up to date.



David Ludlow

RAVES

Its rivals may consider Uber to be evil, but the technology behind the online taxi service firmly brings cabs into the 21st century

UBER IS THE company that everyone loves to hate. Whether it's black cabs going on strike or the CEO suggesting the company should dig up some dirt on a journalist that had written bad things about them, Uber doesn't have a nice and cuddly image. Once you get over that, though, the simple fact is that Uber and its technology are brilliant.

If you've not used it yet, here's how it works. You pull out your phone and fire up the Uber app, which detects where you are. You search for where you want to go and hit the Request button, and the closest driver accepts your fare, drives over to you and takes you to your destination.

Once you've had a fare accepted, you get sent the incoming car's registration and a photo of the driver, and you can see exactly where the car is on the map, so

finding your ride is easy. When you're on your way, you can send ETAs to friends and family, who know exactly where you are. Even better, all the payments are handled electronically via credit card or PayPal, so you don't need any cash or work out how much shrapnel to leave as a tip. There's no chance of getting lost, either, as all the drivers use GPS through their Uber app, taking you directly to where you want to go.

Uber is so brilliant that on a trip to Johannesburg to visit friends we were told to use the service, as the local taxis aren't very good. First time in a new city and a bit dubious of everything, we decided that the official airport taxis would be a better and safer option. Hours later, after the driver had gone the wrong way and had driven round and round trying to find our friend's

house, we realised we'd gone wrong. On the way back we used Uber, and it was cheaper, direct and the driver had sat nav to make sure that he didn't get lost.

There are some concerns about how Uber is run, but in the UK its drivers have to undergo a DBS check and require a private hire licence, making the service very safe to use. In fact, most of the criticisms of it come from existing taxi companies, who have a vested interest in making sure that you use their service rather than Uber's.

However, the point here isn't about that, but how brilliant Uber's technology is compared to the competition. Rather than trying to knock Uber, we need to see more of this type of technology rolled out everywhere. 📱

Windows 10 brings desktop computing to your mobile

MICROSOFT HAS UNVEILED the latest features of Windows 10 at its annual Build Conference in San Francisco. Top of the bill is Continuum, which is designed to make the OS work seamlessly on hybrid laptop and tablet devices thanks to Microsoft's Universal Windows Platform. This enables developers to create a single application that can run across all Windows 10 devices. Microsoft has already shown how the system works on its own Surface Pro 3 to great effect.

PORTABLE PC POWER

The missing piece of the puzzle was how Windows 10 would work on smartphones, and Microsoft's Joe Belfiore took to the stage to show how its new Windows 10 Mobile operating system would be able to transform your mobile into a full desktop experience.

By plugging the Windows handset into a monitor via HDMI and connecting a Bluetooth mouse and keyboard, Belfiore showed Build's audience how you could use your phone as a portable PC. Since all Windows 10 apps share the same code, Belfiore was able to run full versions of Office apps from his phone.

He also showed how Office can instantly switch between the mobile version and its usual desktop layout, allowing for familiar use of these powerful productivity tools. The handset still functioned independently, so you could answer a text message or take a call while you continued working on the monitor.

"You simply connect your phone, and then your Outlook mail experience (which you use on the phone screen all the time) now scales up to be a full PC-like experience," said Belfiore. "You can use the mouse and keyboard, you'll see all your folders on the left [and] all your messages in the middle. You can

preview them on the right and when you reply, you're using the full power of Word, which is also built into your phone. All your keyboard shortcuts will work the way you expect and you can get work done very effectively using your phone like a PC."

These features won't be available on current Windows Phone handsets, as these devices are currently only capable of mirroring their display on to a second screen rather than displaying a proper extended desktop. Instead, Belfiore said we'll need new hardware with Qualcomm processors that can drive two screens before we can start using our phones

MOBILE UPDATES

Microsoft's Terry Myerson said the company plans to wrest back control of the OS update process for Windows 10 Mobile. Currently, many Windows Phone owners are at the mercy of network operators when it comes to receiving updates, meaning some devices have to wait longer than others before they can enjoy the very latest features. Thankfully, this should change with Windows 10 Mobile.

"[We] continuously probe our software with leading-edge techniques, and proactively update supported devices with necessary updates to address issues," said Myerson.

Office can instantly switch between the mobile version and its usual desktop layout

as portable PCs, but the possibilities for such technology is huge.

Imagine being able to carry a full Windows Office suite with you everywhere in your pocket; hook it up to a hotel TV and you'll need only a compact Bluetooth keyboard and travel mouse to complete the set.

The idea isn't completely new, as Motorola's Atrix smartphone attempted to provide a similar desktop experience with Ubuntu when it was first unveiled at CES in 2011. However, that didn't have the benefit of a familiar Microsoft desktop environment and applications.

We shouldn't have to wait long for Windows 10 Mobile devices, as Belfiore said that Continuum for phones will be available on new Windows 10 handsets after Microsoft launches the main OS this summer.

"And today, we're announcing this continuous update process applies to all Windows 10 devices, including phones."

This should also make devices more secure and reduce version fragmentation, making life a lot easier for app developers.

ANDROID AND iOS ON WINDOWS

Windows Phone is in many ways an impressive operating system, but it has always been somewhat stymied by a lack of app support, with many developers understandably concentrating on the market-leading Android and iOS platforms. With Windows 10 Mobile, Microsoft wants this situation to change.

At its Build conference, Microsoft released a set of tools to make it simpler for Android developers to port their apps to Windows 10 Mobile devices. During a live demo, the company showed how a hotel booking app running on Android could be made to look and operate in exactly the same way on Windows.

It's also doing the same for iOS, creating an Objective-C compiler to help iOS developers re-use code on Windows 10 phones and tablets. These iOS apps will have access to even more features than they do on Apple's devices, such as integration with Microsoft's Cortana voice assistant, Live Tiles on the Start screen and more.

This should mean that Windows 10 Mobile won't miss out on so many major apps, so it should be able to differentiate itself on its own merits, rather than being dismissed by consumers because it doesn't have a certain app they need.

↓ Once new Windows 10 Mobile devices arrive, you'll be able to use it as a portable PC when you're on the move



Windows 10 launch date revealed

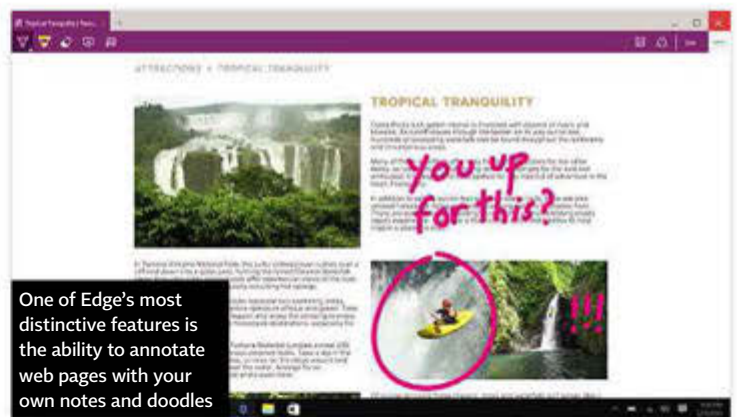
MICROSOFT HAS REVEALED that Windows 10 will launch on 29th July. Announced on the Microsoft Blog, the company's new operating system will be available globally in 190 countries.

Microsoft also reiterated that the free upgrade to Windows 10 from Windows 7 or 8.1 will be available for one year from the launch date. After a computer has been upgraded to Windows 10, Microsoft will support it for the life of the product at no additional cost.

To reserve a free upgrade of Windows 10, Windows 7 and 8.1 users should look for a small Windows icon in the notification area in the bottom right of their screen. This is the Get Windows 10 App; you simply click on the icon and select 'Reserve your free upgrade'. You'll get a notification when your upgrade is ready and be able to install it at a convenient time. You can cancel the reservation at any time.

Microsoft had yet to announce the full details of availability when we went to press. As such, it's not yet clear whether you'll be able to buy a fully boxed version on 29th July, or whether this date is only intended for those upgrading to Microsoft's new operating system.

There's a good chance that subscribers to the Microsoft Developer Network will get copies slightly earlier than 29th July, as the ISO files are typically made available when the software is locked down and ready to be Released to Manufacturing (RTM). Look out for full availability details in next month's issue.



Internet Explorer successor has the Edge

WINDOWS 10 MAY have been top of the agenda at Microsoft's Build conference, but the company also announced the official name of its new internet browser. Previously known as Project Spartan, the successor to Internet Explorer will be known as Microsoft Edge.

Microsoft says it chose the name as it reflects its commitment to deliver a browser that lives at the edge of modern web standards. The new app will be the default browser for everything from phones to workstation PCs, although IE will continue to be available as a separate download to support businesses that have built applications round it.

Taking several cues from Google Chrome, such as tabs in the title bar and an address bar inside those tabs, Edge should be a lot slimmer and faster than its predecessors. It will support Cortana, Microsoft's personal digital assistant, a Reading List for saving web pages for offline reading and syncing between devices, an annotation feature to share with other Edge users and clipping web content.

Edge is available to try in the current build of the Windows 10 Technical Preview. At the moment, the Reading List and annotation features are available, but it still lacks basic functions such as a Home button and dragging tabs off to make new windows.

In previous builds, Edge was one of the most unstable parts of the Windows 10 Insider Preview. Microsoft seems to have ironed out these issues, but we'll be keeping an eye on how it progresses.

Sony takes on iPhone 6 with new Xperia Z3+

THE NEXT SONY Xperia smartphone will not be called the Xperia Z4 in the UK. In a surprise move, Sony has announced that its next flagship Xperia handset will be called the Xperia Z3+ when it launches this summer, although bizarrely it will still be known as the Z4 in Japan.

It's not a huge upgrade from Sony's existing Xperia Z3 handset, but the new phone will add 64-bit processing to the mix, two brand new colours and an even slimmer, lighter chassis. Measuring just 6.9mm, the Xperia Z3+ will be Sony's thinnest flagship Z series smartphone to date. This is the same thickness as the iPhone 6, but the Xperia Z3+ is a little heavier, weighing 144g rather than Apple's 129g.

Like previous Xperia Z phones, the Xperia Z3+ has a metal frame and glass rear and will be water- and dustproof. Sony will be kitting it out with a waterproof capless Micro USB port like the Xperia Z4 Tablet and upcoming Xperia M4 Aqua. This means you won't have to worry about whether you've closed the USB port if you happen to drop the phone in the bath.

The display has kept the same 5.2in Full HD 1,920x1,080 resolution Triluminos display as the Xperia Z3 and Z2, but the Xperia Z3+ will be powered by a 64-bit octa-core Qualcomm Snapdragon 810 chip and 3GB of RAM, so it should have plenty of power to compete with

Samsung, HTC and LG's latest offerings. It will also support Sony's PS4 Remote Play feature, which lets your smartphone double up as a portable display for a PS4 over your home network. Its 2,900mAh battery will have a quick-charge feature as well, providing a full day's use from just 45 minutes of charging. The Xperia Z3+ will have 32GB of onboard storage, but this can be expanded up to 128GB via microSD card.

One slightly disappointing piece of news is that the Xperia Z3+ will use the same 20.7-megapixel rear camera that Sony's used since the Xperia Z1. Like previous iterations, it has a 1/2.3in Exmor RS mobile sensor, but it has one minor upgrade in the form of an improved 25mm wide-angle Sony G lens and Bionz processing engine.

Sony has included a few software improvements, too. Superior Auto mode will recognise up to 52 different scenarios, including the new 'Gourmet Mode' which seems to have been designed to appeal to Instagram foodie fans. Superior Auto mode will also be making its debut appearance on the 5-megapixel front-facing camera. New modes include Soft Snap, Backlight Portrait and Infant, so it should be able to produce better low-light pictures.

Sony has yet to reveal pricing or a launch date for the Xperia Z3+, but it will be available in aqua green and copper as well as white and black. Based on how much the original Xperia Z3 cost at launch, we would expect the Xperia Z3+ to cost around £500 SIM-free.



New iD network brings free 4G to UK

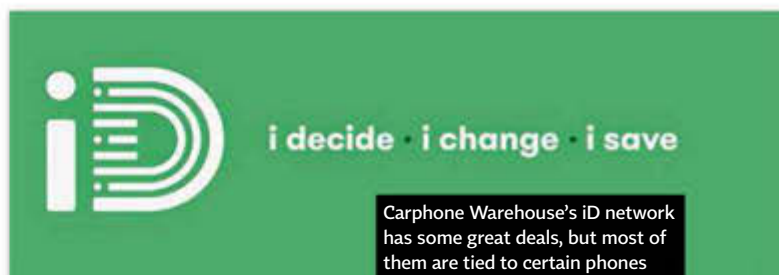
CARPHONE WAREHOUSE HAS launched its brand new iD mobile network in the UK. The service, which runs off Three masts to provide free 4G at no extra cost, aims to provide some of the best-value 4G plans on the market, with contracts starting at just £7.50 per month.

These 'Shockproof' plans are automatically capped to avoid any nasty surprises at the end of the month. They also have a £5 buffer, which customers can view and change through their account. However, iD's Shockproof deals only go up to 1GB of data, so anyone wanting more will likely need one of the more flexible 'Go To' plans. These include 12-month contracts starting from £13.50 per month.

iD will also be good news for those who use their phone abroad, as its 'Takeaway' free roaming plans cover more European countries than any other network. It will cover 22 countries in total, with all but two of them (the US and Australia) in Europe, beating Three's total of 18 countries with its Feel at Home service, only 10 of which are in Europe.

iD contract deals are only available on certain phones, which may be limiting if you have your heart set on a particular handset. The cheapest pay monthly deal (which gives you 150 minutes, 5,000 texts and 250MB of data for £7.50 a month) is only available on the Nokia Lumia 635.

A better bet is likely to be one of iD's SIM-only deals if you're thinking of switching networks. These also start from £7.50 a month,



and this gets you 250 minutes, 5,000 texts and 500MB of data, or 100 minutes, 5,000 texts and 1GB of data. This compares favourably to other cheap SIM-only providers such as GiffGaff, whose cheapest 4G SIM deal costs £12 a month and gives you 500 minutes, unlimited texts and 1GB of data. You also get more data for your money on iD than you do on Three, as Three's £10-a-month SIM-only deal gets you just 500MB of data along with 100 minutes and 3,000 texts.

iD will be available to customers from all Carphone Warehouse stores and online, as well as through all Currys and PC World stores now that the company is part of the Dixon Carphone family.

LG unveils 1mm thick OLED 'wallpaper' TV

LG DISPLAY HAS shown off its latest OLED TV in Korea: a 0.97mm thick 'wallpaper' TV that weighs just 1.9kg and can be pressed on to your wall via a magnetic mat. To remove the TV, all you need to do is peel it off the mat like a sheet of paper.

That's pretty impressive for a 55in set, especially when LG's current flagship OLED TVs measure 4.3mm thick. This is mainly because the wallpaper TV doesn't have any of the traditional circuitry you'd normally find in a TV, as the vast majority of it was hidden away off-screen during LG's unveiling event.

Still, even if the wallpaper TV never makes its way to shop floors, it's a clear indicator of where LG Display (LG's dedicated OLED subsidiary) wants to take its panels in the future. According to Korean news site Yonhap, LG Display has promised to ramp up OLED production so that it can meet customer demands toward the end of this year.

"We should be able to supply a satisfactory volume to our clients from July or August," said LG Display's Sang-Deog Yeo. "It has taken a year and half for us to raise the yield to this level [for OLEDs], while it had taken nearly 10 years to achieve the yield for LCDs," he added.

OLED has often been heralded as the future of TV, as it combines the best of LCD and the now-defunct plasma technologies. With OLED, pixels generate their own light source rather than being illuminated by LEDs or fluorescent tubes, so pixels that need to display black can simply switch themselves off, leading to much deeper blacks than your

LCD sets. Since OLED is emissive, it doesn't need a bulky backlight integrated into the TV, allowing for super slim panels.

However, OLED can be tricky to manufacture, hence the current low yields and eye-wateringly high prices.

LG Display said it hoped to sell 600,000 OLED panels by the end of the year, and 1.5 million units by the end of 2016.



LG's latest concept TV can be peeled off your wall like a sheet of paper

Three's VoLTE service kills 4G blackspots

THREE HAS ANNOUNCED plans to extend its 4G network coverage by switching on a new 800MHz spectrum in September. Dubbed VoLTE (or Voice over LTE), the low-frequency spectrum will run alongside its existing 2,100MHz 3G and 1,800MHz 4G spectrums to help improve its coverage footprint, namely by getting those 4G bars to finally appear on your smartphone from inside your own home.

Three's 4G network currently only runs data services, so if you want to make a call, you'll automatically fall back on to its 3G network. VoLTE, however, will enable voice services to run on 4G as well, enhancing the quality of your calls while speeding up connection rates and set up times.

Speaking to *Shopper*, Three's chief technical officer Bryn Jones likened the VoLTE service to the thumping bass you might hear from a party down the street. As it's a lower frequency, it can travel much further than standard 4G – up to three times further, according to Jones – allowing it penetrate those hard-to-reach areas normal 4G signals can't get to.

"Our aim is to keep our customers connected wherever they are," said Jones. "Adding low-frequency spectrum to our network and enabling voice calls over 4G and Wi-Fi will mean Three customers can stay connected in more places than ever before."

"With roaming at no extra cost also available in 18 destinations, Three is doing more than any other network to give our customers a reliable, quality experience wherever they are."

Three expects more than 1 million customers to start using VoLTE by the end of the year, and estimates that 3.2 million homes will be able to benefit from VoLTE in 2016. However, there is a slight catch. You need a compatible phone in order to use it, so any handset more than two years old, such as the Samsung Galaxy S4, is unlikely to support it.

Three assured us almost all this year's major flagship phones will be able to support the service when it's switched on. However, older handset owners will need to check their phone to see if it's compatible.

Three wouldn't be drawn on whether O2 customers would get its VoLTE service when its on-going buyout eventually goes through but, if the takeover is successful, we wouldn't be surprised if VoLTE became available across its entire network, O2 customers included.



Microsoft's Cortana is heading to Android and iOS devices

MICROSOFT'S CORTANA

VOICE assistant will be launched as an app for both iPhone and Android, the company has announced. Although the rival operating systems already have their own voice assistants – Siri and Google Now – Microsoft is hoping to muscle them aside with the system that's also built into Windows 10.

"Part of the power of a personal assistant comes from being available on the device you carry with you everywhere," wrote Microsoft corporate vice-president Joe Belfiore on the Windows blog. "And for people who don't have the benefit of a Windows phone, we want to extend the advantage of Cortana in Windows 10."

Microsoft says the iOS and Android versions of Cortana will be able to do "most" of the things that the Windows Phone version can, such as setting reminders and alarm calls, tracking flights and delivering notifications for appointments, as well as answering voice search queries. However, because Cortana isn't directly embedded into iOS



↑ Cortana on Android and iOS will be similar to the Windows version, but some features will be exclusive to Microsoft's smartphones

or Android, it will lack some of the features it has on Windows Phones.

"Some features require access to the system that aren't currently possible with iOS or Android, so things like toggling settings or opening apps won't initially be available in the Cortana companions for those platforms," said Belfiore. "Similarly, the ability to invoke Cortana hands-free by saying 'Hey Cortana' requires special integration with the device's microphone, so that will be limited to Windows Phones and PCs."

Cortana can be installed on iPhones and Android handsets via a new Phone

Companion app that's being built into Windows 10. Microsoft will also offer an Xbox Music app on the rival platforms, which will allow users to stream any music stored in their OneDrive on their mobile phone for free.

The Cortana app will be released on Android at the end of June, while iPhone users will have to wait until "later in the year".

Apple adds Force Touch to 15in MacBook Pro

APPLE HAS UPDATED its 15in MacBook Pro range, adding a Force Touch trackpad, faster flash storage, discrete graphics and a longer-lasting battery. It's also slashed the price of its 5K iMac to just £1,599. Both that model and the more highly specified £1,849 5K iMac now cost less than the £1,999 original.

The Force Touch trackpad has built-in force sensors that allow you to customise the amount of pressure needed to register a click. It also adds a third Force Click, which performs different actions based on context; for example, it will bring up a preview when you click a link in Safari. The expansion of Force Touch suggests it might not be long before we see it being integrated into the rest of Apple's MacBook line-up.

The faster flash storage on the 15in MacBook Pro is up to two and a half times quicker than the previous generation,

with a throughput of up to 2.5GB/s. As a result, Apple says this will prolong the MacBook Pro's battery life by an hour, providing up to nine hours of surfing the web or nine hours of video playback. As for the 15in MacBook's new graphics options, Apple has added the 2GB AMD Radeon R9 M370X chip, which sits alongside the existing Intel Iris Pro Graphics chipset. The new 15in MacBook Pros cost £1,599 and £1,999.

For the 5K iMac, which has a huge resolution of 5,120x2,880, Apple has added another configuration. The cheaper £1,599 model has a quad-core 3.3GHz Intel Core i5 processor, which Turbo Boosts up to 3.7GHz, an AMD Radeon R9 M290 graphics chip, 8GB of RAM, 1TB of storage, four USB3 ports and two Thunderbolt 2 ports.

Meanwhile, the more expensive

£1,849 model has a 3.5GHz Intel Core i5 processor that can Turbo Boost up to 3.9GHz, an AMD Radeon R9 M290X chip, and a 1TB Fusion Drive.

→ In addition to the Force Touch trackpad, the new 15in MacBook also has faster storage and enhanced discrete graphics



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PATRIOT VIPER RED V3 8GB 1600Mhz
2TB SATA2 3Gb/s
SONY 24X DVD+-RW
nVIDIA GTX660 2GB



Experts identify virus that trashes your PC if it's detected

SECURITY EXPERTS HAVE identified a malicious new virus called Rombertik that steals personal details and wrecks your computer if you attempt to remove it. Unlike most modern viruses, which normally avoid drawing attention to themselves so they can continue to steal data quietly, Rombertik makes a notable nuisance of itself.

Rombertik arrives in the form of a phishing attack, hoping to entice users to click on a malicious attachment. Sample messages used in the attack include a fake email from Microsoft, asking the recipient to click on an attachment to check a technical specification. That attachment is, of course, not the innocent PDF it purports to be, but a screensaver application that installs Rombertik, according to a blog post from Cisco researchers Ben Baker and Alex Chiu.

Rombertik is designed to steal passwords and other sensitive information entered into the browser. The stolen data is sent back to a server controlled by the malware writers. The virus comes with 75 images and over 8,000 redundant functions to try to fool security software into thinking it's a legitimate app.

However, it turns nasty if its malicious activity is rumbled. At the point of installation and before it's even attempted to steal personal data, Rombertik will check to ensure its code isn't being analysed by security software. If it detects that it is, the malware is programmed to destroy the PC's Master Boot Record, putting the PC into an endless reboot loop where it does nothing but start up and shut down again. If the malware can't get to the Master Boot Record, it will instead encrypt all the files in the user's home folder.



"Rombertik trashes the user's computer if it detects it's being analysed," says Cisco's research team. "It's unique in that it attempts to destroy the computer if it detects certain attributes associated with malware analysis."

Up-to-date antivirus software should stop Rombertik being installed in the first place, but Cisco advises that companies should block certain attachment types on employees' PCs to prevent this type of attack.

TalkTalk blasted for 'misleading' broadband ads

TALKTALK HAS been reprimanded by the Advertising Standards Authority for claiming that its broadband connections are "99.9% reliable". Four complainants challenged whether TalkTalk could substantiate the claim. It turns out it couldn't.

The company based the claim on the reliability of telephone exchanges, rather than actual broadband connections. In its defence, TalkTalk said it had "measured the availability of telephone exchanges from January to August 2014, which was calculated to be 99.9986%". The company added that "other factors beyond TalkTalk's control might affect availability, which was explained in the promotion's terms and conditions".

Given that BT is responsible for maintaining telephone exchanges, and that TalkTalk is only responsible for maintaining its own equipment in exchanges where the lines are 'unbundled', it's hard to fathom how TalkTalk could possibly extrapolate that figure to signify the reliability of its broadband connections. The Advertising Standards Authority wasn't impressed, either.

"We considered most consumers would be interested in the reliability of their end-to-end broadband connection up to the point of their router or into their home, rather than the reliability of certain portions of the overall connection," the ASA ruling states.

The company was told to stop running the ads and "ensure future ads made the basis of network reliability claims sufficiently clear".

Wi-Fi signals may suffer as Ofcom auctions new spectrum bands

OFCOM IS TO auction off more radio spectrum to Britain's mobile networks – but admits it could cause interference with existing Wi-Fi equipment. Ofcom plans to sell two tranches of spectrum that are currently being used by the Ministry of Defence: the 2.3GHz and 3.4GHz bands. The 2.3GHz band sits adjacent to the 2.4GHz band that is currently used by Wi-Fi routers, raising the possibility that new mobile equipment will interfere with Wi-Fi signals.

The telecoms regulator says it has conducted extensive tests and believes the risks of interference are slight. "For Wi-Fi, we have concluded that the likelihood of interference is very low and, even if it occurs, many users will not even notice," Ofcom's consultation paper states.

"The most important and effective mitigation is for the Wi-Fi router/device to use the alternative 5GHz Wi-Fi band," Ofcom's paper adds. "Almost all new Wi-Fi equipment has this capability. If the equipment is able to switch automatically then consumers will not even notice this has occurred. However, some older equipment which is able to operate at 5GHz may need to be switched manually."

Whilst it's certainly true that most modern routers offer both 5GHz and 2.4GHz bands, many users leave their routers running on 2.4GHz only,

➔ Ofcom is concerned that low-powered cellular base stations could harm current Wi-Fi signals when it auctions off two tranches of spectrum later this year

because some older kit isn't compatible with 5GHz. In many instances, 2.4GHz also offers a more reliable signal. Older routers may not have the option of switching to 5GHz, potentially forcing users to upgrade.

Ofcom is concerned that femtocells – low-power base stations that are often supplied by mobile networks to boost mobile signal in a home or business – could harm Wi-Fi signals. The regulator says it will "encourage manufacturers to place stickers on 2.3GHz femtocell equipment to advise about suitable separation distances from Wi-Fi routers".

Ofcom plans to auction the spectrum late this year or in early 2016. However, it admits the shake-up currently occurring in the mobile industry could harm the price it fetches. "Since Ofcom's last consultation on the auction, BT has announced plans to buy EE, while Hutchison Whampoa – the owner of Three – has reached agreement to acquire O2 from Telefónica," the regulator notes.

Ofcom says it has no power to intervene in the proposed mergers, but will design the auction to ensure that none of the merging companies gains an unfair advantage.



Google's self-driving cars have crashed 11 times

GOOGLE HAS ADMITTED its driverless cars have been involved in 11 accidents – but claims human drivers were to blame for all of them. Google is one of the few companies that have been granted permission to test autonomous vehicles on public roads in the US. Following reports that its cars had been involved in several prangs, the company has published a blog post detailing the cars' accident record.

"If you spend enough time on the road, accidents will happen whether you're in a car or a self-driving car," wrote Chris Urmson, director of Google's self-driving car program. "Over the six years since we started the project, we've been involved in 11 minor accidents (light damage, no injuries) during those 1.7 million miles of autonomous and manual driving with our safety drivers behind the wheel, and not once was the self-driving car the cause of the accident."

Google says seven of the accidents were a result of the vehicle being struck from behind.

The Google cars have also been 'side-swiped' twice and struck by a car that passed through a stop sign.

All the cars in Google's tests currently have a human safety driver behind the wheel who is able to assume control if the computer should fail, but Google ultimately intends to remove the steering wheel and other driving controls, leaving occupants powerless to prevent accidents. The vehicles' ability to avoid accidents will therefore be paramount in the minds of potential buyers and legislators.

Even though Urmson insists the accidents haven't been the cars' fault, he says the company has still been able to learn from each incident. "Not only are we developing a good understanding of minor accident rates on suburban streets, we've also identified patterns of driver behaviour (lane-drifting, red-light running) that are leading indicators of significant collisions," he wrote. Urmson says Google has now programmed the cars to



⬆ If you'd driven 1.7 million miles, you'd probably have a few accidents to your name as well

'pause briefly' after the traffic lights turn green at crossroads, for example, to minimise the chances of a collision with a distracted driver who's failed to notice the lights.

Of course, there are some examples of driver idiocy that it's almost impossible to account for. Urmson provides stills from camera footage showing the Google car safely passing vehicles driving on the wrong side of the road and avoiding collision with cars that have chopped across the Google car's lane. Little wonder Google insists its cars will prove far safer than when we are behind the wheel.

Malicious text message can crash iPhone 6

A SERIOUS BUG in iOS is allowing pranksters to crash other people's iPhones simply by sending them a text message. Users who receive the message can find themselves locked out of their Messages app or have their phone switched off automatically when receiving the text.

The message, which comprises a specific string of symbols and Arabic symbols, first came to light on Reddit at the end of May. Users who received the message saw their iPhones crash instantly. Once the phone had rebooted, the Messages app would also crash if users tried to open it.

Computer Shopper wasn't able to replicate the bug, but several reputable tech publications verified that the message was indeed effective, including The Verge and Mac Rumours. Twitter was also awash with users complaining they had been sent the offending message.

The malicious message is reportedly effective when sent from Android and Windows Phone handsets, as well as other iPhones. Senders of the message can unlock the victim's handset by sending them another text message, but that relies on the goodwill of the sender. Sending yourself a text message from another device or telling Siri to 'send a message to myself' may also clear the bug.

Reports suggest victims can also cancel out the malicious message by replying to the offending text via the iMessage service on Macs,

but that only works if the message was sent via iMessage in the first place. Not every iPhone user will have access to a Mac, either.

A simpler workaround is to go into Settings from the Home screen, tap Notifications, Messages and toggle Show on Lock Screen to Off.

Speaking to iMore, Apple confirmed that it is aware of the bug caused by these Unicode characters and is working on a fix that will be made available in a software update.



EE and BT top Ofcom complaints charts

NEW FIGURES RELEASED by Ofcom confirm the forthcoming merger of BT and EE will see two of the worst customer service records in the industry combined. The regulator's latest figures make painful reading for the two companies, which are midway through a £12.5bn takeover.

Ofcom has lowered the threshold for its latest customer satisfaction round-up, now including companies with as little as a 1.5% share of the market in its reports. That means EE is included in the figures for landline telephone complaints for the first time.

EE went straight to the top of the landline complaints charts, recording 0.33 complaints per 1,000 customers in Q4 2014. That put it just above another a new entrant, BT-owned Plusnet. Plusnet, TalkTalk, BT and Post Office HomePhone all consistently generated levels of complaints that were above the industry average for landlines.

Things didn't get any better for the merging pair when it came to broadband. EE was again worse than any other provider, registering 0.42 complaints per 1,000 customers in Q4 2014. BT was the second most complained about provider, with Plusnet and TalkTalk also doing badly.

EE was the most complained about mobile network for two of the past three quarters, with Vodafone also seeing a spike in complaints in Q4 2014. To further compound a miserable report for the merging duo, BT was also the most complained about TV provider. Although BT has witnessed a huge drop in the number of complaints about its TV service, it still recorded a level that was five times the industry average.

Ofcom is undertaking a 'Strategic Review of Digital Communications' which will supposedly "make sure digital communications markets continue to work for consumers and businesses" and take "quality of service for consumers" into account.

In a statement sent to *Computer Shopper*, a BT spokesperson said: "We continue to work hard to improve our customer service, which is a major focus for us. Our own figures show a 25% reduction in complaints in the last year. We have created hundreds of extra service jobs in the UK and we are also investing to improve our systems and processes. In TV, although the number of complaints continues to fall, we accept that we still need to improve."

Google I/O 2015

Google's annual conference showcases what the search giant has been up to

WITH ITS CASH coming from search and advertising, Google could easily have been a very dull company indeed. Instead it has chosen to invest in a mind-boggling range of technologies, some of which may not come to fruition for decades. Google I/O is the company's big annual event where it shows off what its engineers have been working on.

Over a packed two days we saw lots of cool new stuff, some of which you can play with today, while other bits won't reach us for years to come. The new version of Android led the way, with the first developer build of Android M being launched. The company also announced its new Google Photos service, with unlimited free online storage. Looking further ahead we saw Google's latest developments in wearable technology, virtual reality and the internet of things.

ALL YOUR PHOTOS

Android may have had top billing, but the announcement with the biggest impact was Google Photos. This provides free unlimited cloud storage for photos and videos. The only caveat is that photos have a maximum size of 16 megapixels, while video is limited to 1080p.

The new service is available now on Android, iOS and via a web browser. Your phone, tablet or PC will automatically back up photos to the cloud, and you'll be able to upload photos from a memory card, too.

Google has put a lot of thought into how you'll browse your pictures or find a particular shot. There's impressive pinch-to-zoom and tap-and-drag controls on smartphones, for example. You can quickly select anything from a single photo to hundreds of images spanning days, weeks, months or even years.

Google scans each photo and guesses its content, giving you a powerful search tool. For example, we searched for 'cars', 'food' and 'Christmas 2012' and in each case it provided an appropriate selection of snaps. It also creates storybooks from your photos, most commonly for holidays and day trips, which combine video, still images and maps to great effect. There's also an assistant, which automatically builds collages, animations and panoramas from the photos you upload.

Sharing is simple, too: you can send a link to anyone, whether they have Google Photos or not, and they will be able to click that link and go to a web page displaying your selected



↑ Google's new photo service provides unlimited free storage and powerful automatic tools, and could be revolutionary for casual photographers

photos. If they do have Google Photos, with one tap they can then save those photos to their own library of images. It all looks brilliant to us; we've been looking for a good one-stop shop for photo storage, and this could well be it.

IS VR FINALLY HERE?

Google looks to be getting more serious about virtual reality. Last year it launched its 'ghetto' VR viewer – Google Cardboard – which wowed us by turning a smartphone into a VR headset for just a few pounds. This year it's not only pushing that concept into even more hands, but it's also trying to encourage the creation of more VR content.

Google Cardboard Viewer fits larger handsets, up to 6in in size, which covers most of the new big flagship phones and phablets. Compatibility with Cardboard in the past was largely limited due to an over-complex button that set off the magnetometer in the phone. The new button taps the phone's display and so will work with any handset.

Google is also leading the charge when it comes to VR content. For a start there's support for virtual reality in YouTube coming this summer, along with better curation of VR content in the Play Store, with apps being certified that they work with Cardboard.

Dial M for Android

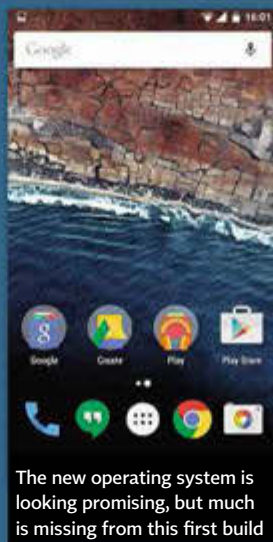
A new version of Android would usually be huge news, but the first build of the Android M Developer Edition makes only relatively small changes to the current Lollipop incarnation, and some of those changes aren't available in this first build.

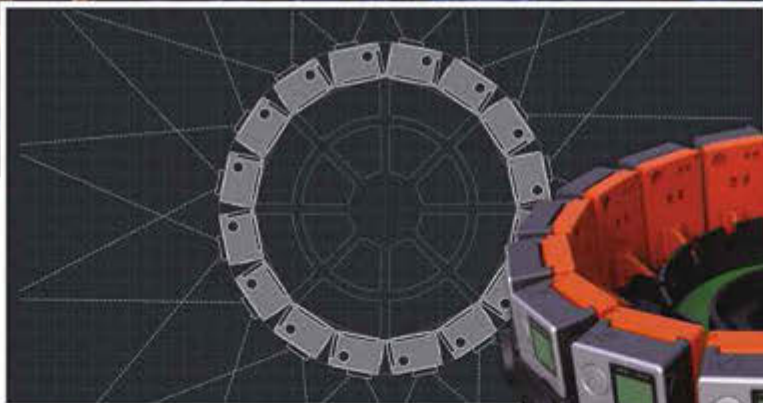
Now on Tap is a headline Android M feature notable for its absence. This takes the Google Now personal assistant and makes it accessible across the whole operating system. You simply hold down the home button and the personal assistant pops up and offers services based on the content you're looking at. For example, if a friend sends an email about going to see a film, Now on Tap will offer reviews of the movie and places to book a ticket. It's a powerful-looking tool, but we've yet to test it for ourselves.

Buried somewhere in the build, but inaccessible to us as we went to press, is multi-window support. For the first time you'll be able to have two apps open side by side in standard Android (although we have seen this before in Samsung's spin on the operating system).

Features that have made the cut can be filed away under 'boring but important'. Google has completely reworked its app permissions system, so apps ask you for access to areas (such as the camera or contacts list) as they need them, not at installation. This should make installs and updates much quicker and smoother and let you control what your apps access in a more mindful way. It's also reworked Lollipop's volume controls, so they're much clearer now, and there's a redesigned Do Not Disturb mode too. Finally, the app tray has been reworked as a horizontal scrolling list.

Google is also claiming much improved battery life in standby mode, but it's too early to get excited yet.





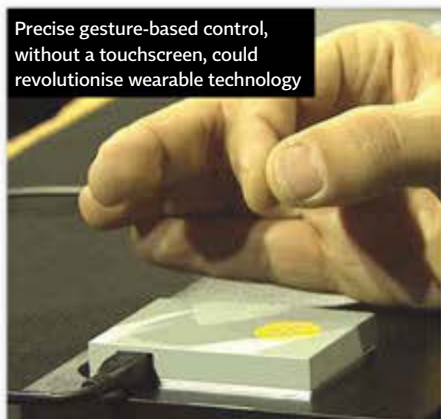
↑ With a new viewer and new capture technology, Google is looking to push VR content through YouTube

Google also has a plan to kickstart a load more VR content for all those Cardboard owners to gawp at. It's called Jump, and it's a hardware blueprint that allows anyone to build their own 16-camera capture array for VR video capture. You could try and knock one up yourself, but the clever people at GoPro have already made one to save you the effort.

Jump isn't just hardware, though: there's some very clever software involved, too. It takes the input from the 16 cameras and processes all the data to create a single, unbroken virtual experience from 16 separate cameras, all in stereoscopic 3D. It sounds mind-bogglingly complex, but the results look great. With an easy way to watch VR, and more content set to be released, VR could finally be here thanks to Google.

UNDER THE RADAR

Google is worried that we're pushing at the limits of what human beings are capable of, or willing to endure, in terms of fiddly interfaces. With devices set to shrink yet again, as wearables supposedly become the next tech fad, Google has been looking at alternative input devices to the touchscreen. What it's come up with is a tiny radar chip that can sense gestures made by your hand.



Precise gesture-based control, without a touchscreen, could revolutionise wearable technology

It sounds a bit like

Microsoft's Kinect, but it works on a much smaller scale, detects much finer motions, and just as importantly is far more compact. It can track your motions at 60fps, giving quite fine feedback, although when you're talking about quick and fine gestures it could be improved. It uses a broad radar beam to track your hand.

A demo showed the device accurately tracking a hand making gestures a few inches from the device. By rubbing a finger and thumb together, the demonstrator controlled a virtual dial, and scrolled through a virtual menu. It all looks very promising and a kit will be available later this year, so that developers can start building hardware and apps to make full use of the technology. The idea of making gestures above your smartwatch on a larger 'virtual' space should help when interacting with tiny screens.

GOOGLE AND LEVI'S

Google also announced an unexpected partnership, with the technology giant working with one of the world's most iconic clothing brands, Levi's. The two companies

are set to produce smart clothing, the next generation of truly 'wearable' technology, though a release date hasn't yet been set.

This joint effort has come out of the company's freshly announced Project Jacquard. Google has been hard at work developing smart fabrics that

integrate conductive touch interfaces right into the weave of clothing. In doing so, the company could soon integrate a touchpad seamlessly into the arm of your sofa, so you can control your TV without a remote, or add one to the sleeve of your jacket, giving you a far bigger space to make inputs and gestures than a smartwatch can provide.

Google looks to have had an uphill struggle with all this. For smart garments to become popular it has to crack the puzzle of mass production; it says 160 times more garments are sold every year than smartphones. Google found that conductive thread (which you may have seen in gloves) only comes in one colour at present – grey – which isn't going to work for the fashion industry.

The weave has to be done specially so the conductive threads all come out neatly and can be hooked up to the electronic chip that detects your inputs. The demo showed the fabric to be sensitive to inputs, whether that's a single finger, multitouch or even gestures made above the surface of the fabric.

The 'softwear' is just the first step in this process, with Google having to produce a whole software pipeline to support it. You're not going to be buying smart clothes quite yet, but the technology is already here and, with Levi's onboard and helping with the design, manufacturing and retail, we shouldn't have long to wait. 📱



With Project Jacquard, Google has woven a touchpad into clothing, which could prove a turning point for wearable tech

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VERDICT

Incredibly small and light, without compromising usability, but the performance and price may put some off

NOT SINCE STEVE Jobs pulled the original MacBook Air out of an envelope have we been so impressed by a new laptop as we are with the new 12in MacBook. Apple claims it's the smallest and lightest laptop it's ever made, but it's not until you get one in your hands that you realise what this means.

Thanks to some clever construction there's barely any depth to the laptop at all, with the thickest part measuring just 13.1mm. Then there's the weight: just 920g, which is just shy of 300g less than the 11in MacBook Air. That means you can carry this laptop around with you all day and barely even feel it.

Getting down to this size hasn't forced Apple to compromise on build quality either. The chassis is still aluminium, creating an air of strength and lightness, as well as luxury. Apple has finally integrated wireless antennas into the case, so there's no need for a lump of plastic around the hinge, and even though the screen is just 1.8mm thick, the aluminium rear protects it with only the slightest amount of flex. This laptop will survive being carried around practically constantly.

The new MacBook is available in three colours: space grey, silver and gold. It means that you can now match your computer to your iPhone 6, iPhone 6 Plus or iPad Air 2. All the colours have their own merits, but it's the gold one that really does it for us.

One of the downsides of such a small case is that there's barely any room for ports. In fact, Apple provides just two: a 3.5mm headphone port and the new USB-C. That doesn't sound like a lot, but USB-C is really clever and is clearly the future for devices such as this. As well as doing all the things we've come to expect from USB, the new port also allows the laptop to be charged and works as a video output. The new connector is reversible and smaller than the regular USB-A, which makes it easier to plug in and means that it takes up less space.



That's the good news. The bad news is that to do a lot of the things you'd want to do, you'll need adaptor cables. With no SD card slot there's no simple way of getting photos off a digital camera, and you can't even use it with Apple's Thunderbolt interface. Apple sells an adaptor that has one USB-C port, so you can keep charging, plus HDMI and standard USB outputs, but it costs a massive £65. Even the basic Apple USB-C-to-standard USB cable costs £15. If you just buy the USB-C-to-USB-A adaptor, it means you have to unplug your computer from mains power just to use a regular USB device. Two USB-C ports would have been nice, although it's hard to see where Apple could have put the second port.

Things will improve: more USB-C devices will be available soon and, as it's an open standard, you're not limited to using Apple peripherals, so you should be able to get cheaper third-party alternatives.

UNDER DOCK AND KEY

One of the big design challenges with the new MacBook was fitting in the keyboard, with traditional models requiring more depth. Apple has ditched the old-style scissor mechanism underneath the keys in favour of a new butterfly mechanism, which makes the keys more stable and reduces travel. In fact, there's barely any travel on the keys at all and they move just a fraction when hit.

While the travel has been reduced, the size of the keys has been increased by 40%, with the keyboard stretching from edge to edge. In

effect, you get a full-sized keyboard on a tiny computer. Each key is backlit by an individual LED, so typing in dark rooms isn't a problem. It's a weird sensation when you start typing, as the lack of travel takes a while to get used to. However, we soon got used to the way the new keys work and were typing at full speed in no time. There's plenty of feedback, so it's obvious when you've successfully hit a key.

There's no room for a traditional touchpad, so Apple has used its new Force Touch Trackpad, introduced with the 13in MacBook Pro with Retina Display. This has a haptic feedback engine that uses lateral motion to trick you into thinking you've made a physical click, rather than an electronic one. It's clever and you'd swear you were actually clicking it.

It also has four pressure sensors that pick up how hard you're pressing, so you can use the new Force Touch gestures: press once for a regular click and then press a little harder to activate a Force Click. It's surprisingly useful once you start using it, popping up previews in Safari and Finder, for example. There's an open API for developers to use, so expect Force Touch to become a bigger part of OS X quickly. A setting within System Preferences lets you adjust the click sensitivity, which is great as you can tighten everything up if you're pretty forceful when you click.

In general use the glass touchpad is still one of the best. It's extremely responsive and its multitouch gestures make using the



p28 | Acer Revo One RL85



p33 | LG G4



p36 | Panasonic Lumix GF7



p48 | Amazon Fire TV Stick



p60 | Project CARS

MacBook with OS X 10.10 Yosemite a few steps ahead of any Windows laptop.

DISPLAY FOR TODAY

Apple's MacBook Air screens are starting to look a bit old now, but the 12in screen on the new MacBook is one of the best we've seen. Our colour calibrator measured the display at a dark 0.34cd/m² black level, with a maximum brightness of 375.15cd/m², which makes it easy to see in most lighting situations. We measured colour accuracy at 92.4% of the sRGB colour gamut, which, while not perfect, pushed this display towards the top of the laptop table. Only Dell's high-end laptops are able to beat it for colour accuracy, but you'd be hard pressed to spot the difference with the naked eye.

Our general impressions backed this up, with the display appearing bright and vibrant, with excellent viewing angles. As with all thin displays there's a tiny amount of backlight leak around the sides of the screen, but you have to look hard for this and it's generally not visible in day-to-day use.

Everything looks pin-sharp, too, thanks to the 2,304x1,440 resolution. As with all Retina-class MacBooks, the MacBook uses a scaled resolution, so it acts like a 1,280x800 display in its default mode, only everything looks sharper. We found that changing the display to the More Space setting, which makes it act like a 1,440x900 display, made more sense: everything became a little bit smaller, but the display felt a lot less cramped.

COOL RUNNINGS

Apple has used Intel's Core M processors in its line-up, as they're extremely power efficient and don't require any cooling fans, allowing for the thin case. Our base-level MacBook shipped with a 1.1GHz model, which



can Turbo Boost to 2.4GHz. The processor used is actually a Core M-5Y31, which is nominally a 900MHz chip; however, Intel allows its manufacturers to increase or decrease the amount of power the chip draws, depending on the cooling available, to boost clock speeds. In this case, Apple has increased the TDP from 4.5W to 6W, upping the base clock speed to 1.1GHz. Apple sells a second version of the laptop with a 1.2GHz chip (2.6GHz Turbo Boost), and both models can be upgraded to a 1.3GHz CPU (2.9GHz Turbo Boost) for £200 and £120 respectively. All models ship with a healthy 8GB of RAM, which is the maximum for this model.

In our new 4K benchmarks, the new MacBook scored a respectable 26 overall. It did fairly well in our image- and video-editing tests, with scores of 30 and 33, but our multitasking test pushed the computer to its limits, with a score of 20. This shows that this laptop is better suited to running a single task, and it's not ideal as your only computer. By comparison, the new 13in MacBook Air scored 45 overall; the 13in MacBook Pro was more powerful still, managing 56 overall. This shows that the regular Intel Broadwell mobile processors are a lot more capable.

Apple has used PCI-E-based flash storage in the MacBook, with 256GB and 512GB options available. We found it to be reasonably fast, managing 370MB/s write speeds and 636MB/s read speeds in our tests; slower

than the new MacBook Pro, but still extremely quick.

Inside the MacBook are batteries; lots of batteries. They've been cut, shaped and tiered on top of each other in order to fit inside the case. It's worth all the effort that Apple has gone to, as we've lost count of the number of very tiny laptops that have been hampered by poor battery life. Not so with the MacBook: it lasted 12h 30m in our battery test, which plays a 10m video every three hours, as well as scrolling through a text document. This kind of score shows this laptop will easily get you through a working day without having to go near a power socket.

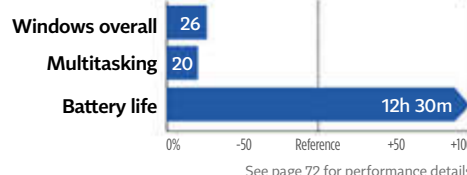
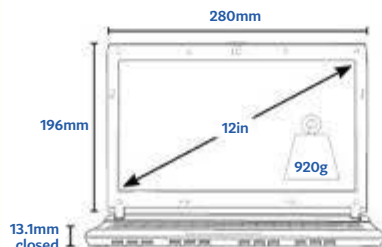
VERDICT

It's hard not to fall in love with the new MacBook. It's a staggeringly brilliant bit of engineering with only a few compromises for its small size. On the face of things, the starting price of £1,049 seems fairly expensive, but it's £30 less than the equivalent 13in MacBook Air with 256GB of storage and 8GB of RAM, and only £70 more than the 11in MacBook Air with 256GB of storage and 8GB of RAM. Given the new MacBook's better display and lower weight, we'd definitely buy it over either of the Air models. Performance is the big issue: it's got enough grunt for simple tasks, making it a good choice as a second computer for working on the move. If you just want one laptop that does everything, however, the 13in MacBook Pro is still the model for you.

David Ludlow

SPECIFICATIONS

PROCESSOR Dual-core 1.1GHz Intel Core M-5Y31 (2.4GHz Turbo Boost)
RAM 8GB
SIZE 280x196x13.1mm
WEIGHT 920g
SCREEN SIZE 12in
SCREEN RESOLUTION 2,304x1,440
GRAPHICS ADAPTOR Intel HD Graphics 5300
TOTAL STORAGE 256GB
OPERATING SYSTEM OS X 10.10 Yosemite
PARTS AND LABOUR WARRANTY One year RTB
DETAILS www.apple.com/uk
PART NUMBER MacBook



PALICOMP Intel i7 Elite

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VERDICT

Plenty of gaming gusto, but the oversized case isn't really taken advantage of

THERE'S NO DENYING the Intel i7 Elite cuts an imposing figure. Its Thermaltake Core V51 Window mid-tower case measures 540x236x560mm, so there's plenty of space inside. However, given its components, there's really no need for such a gargantuan case.

We could understand it if Palicomp had filled it with fans to keep the system cool, but none of the mounts in the top of the case, which can accommodate either two 200mm fans or three 120/140mm fans, is filled. The 120mm exhaust on the back and two 120mm intakes on the front are fairly quiet, though.

Granted, you're left with plenty of space for a big graphics card and multiple storage drives should you feel the need to upgrade, but given the system's performance, that might be a long way off. The Core V51 otherwise isn't bad to look at, and the large viewing window on the side shows off all the components within, but its perforated front panel might be divisive.

QUAD PLAYER

As the name suggests, the i7 Elite is based around a quad-core Intel i7 processor, specifically an i7-4790K that has been overclocked to 4.7GHz. It's cooled by a Zalman CNPS9900A CPU cooler, which is more than capable of handling the additional heat generated by the processor. It's a particularly tall cooler at 152mm, which may go some way to explaining the choice of case, but an all-in-one water cooling loop would be just as effective without taking up so much room.



In our taxing 4K benchmarks, the overclocked processor acquitted itself well, achieving an overall score of 160. It particularly excelled at multitasking, scoring 168. This was helped in part by the 16GB of 1,600MHz DDR3 memory. Two of the four RAM slots on the Asus Z97-Pro Gamer motherboard are empty, so you have the option of adding even more, up to a maximum of 32GB.

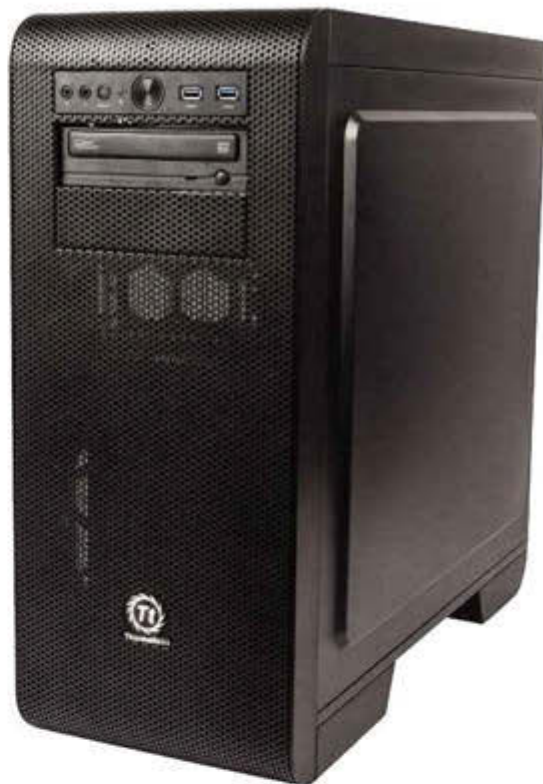
An overclocked Nvidia GTX 980 graphics card helps explain the cost of the system, but it provided fantastic gaming performance. It made light work of Dirt Showdown, managing 155fps at 1,920x1,080, 4x anti-aliasing and Ultra graphics. Even in Tomb Raider with maximum graphics settings it managed a silky 69.6fps. Metro: Last Light Redux as always proved the most taxing with its supersampling anti-aliasing, yet the Intel i7 Elite still managed an excellent 55.3fps at Very High quality settings and 1,920x1,080 resolution. If you're looking for a gaming system that will serve you well for a few years, the Intel i7 Elite should have you covered.

BOOT CAMP

A 256GB Crucial MX100 SSD is installed as a boot disk, keeping Windows 8.1 feeling fast and responsive but still providing room to install your most-played games to keep loading times down. A generous 3TB hard disk is fitted as a secondary storage drive, so you won't need to shuffle files to external disks.

The case has three more dual-purpose drive bays that can accommodate either 2½in or 3½in disks should you want to install more storage. The drive rails are completely tool-free if you're fitting 3½in disks, but you'll need a screwdriver to secure 2½in disks or SSDs. Three of the motherboard's six SATA3 ports are in use, for the two storage disks and the DVD-RW optical drive, and if you want to use SATA Express you'll lose another two. There's also an M.2 port mid-board for installing an M.2 SSD. These carry a slight price premium over standard SSDs, but are great for reducing cabling and improving airflow.

Only two of the PCI-Express x16 slots have the full PCI-E x16 3.0 bandwidth, if you want to



use two graphics cards in SLI or CrossFireX. The third slot is PCI-E 2.0 and operates at x4 speed. One of the PCI slots is obscured by the dual-width graphics card, but the two PCI-E x1 slots at the bottom are free to access. A Corsair CX750 PSU delivers a maximum 750W, which should accommodate most upgrades.

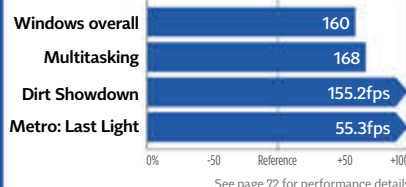
Two USB3 ports and a headphone jack are on the front of the case, with a further four USB3 and two USB ports on the back. You'll also find a PS/2 port, Gigabit Ethernet, optical S/PDIF and six 3.5mm outputs for 5.1 audio. The graphics card has three DisplayPort outputs as well as HDMI and DVI, so you're well covered if you'll be using multiple monitors.

The Palicomp Intel i7 Elite has fantastic performance, and the excellent graphics card and generous amount of storage make it great value. If space is no issue and you're not dissuaded by its gargantuan size, it's a great choice. You also get a decent warranty. If you're looking for something smaller and slightly cheaper, though, the Chillblast Fusion Raptor (Shopper 327) is also a top performer.

Richard Easton

SPECIFICATIONS

PROCESSOR Quad-core 4.7GHz Intel Core i7-4790K (overclocked) • **RAM** 16GB • **FRONT USB PORTS** 2x USB3 • **REAR USB PORTS** 2x USB, 4x USB3 • **TOTAL STORAGE** 256GB SSD, 3TB hard disk • **GRAPHICS CARD** 4GB Galax Nvidia GeForce GTX 980 • **DISPLAY** None • **OPERATING SYSTEM** Windows 8.1 • **WARRANTY** Three years RTB • **DETAILS** www.palicom.co.uk • **PART CODE** HAS11



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VERDICT

A clever design means storage isn't an issue for Acer's brilliant Revo One mini PC

THE REVO ONE is one of the least traditional-looking PCs we've seen in a long time, but Acer's thinking that it would make a great living-room PC goes some way to explaining its unconventional design.

The cuboid design and rounded corners don't demand your attention, making the Revo One the kind of object you won't mind leaving on display in your AV cabinet, but it's small enough to hide out of the way if you prefer. It looks equally attractive in either glossy white or black, and Acer has kept branding to a minimum. The white activity LEDs on the top aren't too distracting, either.

The fact that Acer has managed to make room for three storage disks in a system as small as the Revo One is an impressive feat. It can hold up to 6TB of storage across three 2½in disks, making it an excellent choice as a media server or Windows-powered NAS. Our

18 overall. The score was brought down by poor multitasking performance, a result of the dual-core processor and limited memory. The Revo One won't break any records, and isn't designed for strenuous multitasking, but this score is more than sufficient for a PC that will most likely be used as a media centre. That being said, Windows boot speeds left a lot to be desired, taking upwards of a minute to reach the desktop. An SSD would make a big difference, but it would mean sacrificing storage capacity.

Intel's processors are more than capable of transcoding Full HD video, but unsurprisingly the Revo One isn't cut out for serious gaming. The integrated Intel HD Graphics 4400 could achieve only a jerky 17.8fps in Dirt Showdown



use a combined keyboard and touchpad remote control, which we also tested. The keys are very small, which again means it's really only going to be useful for occasional text entry, but the touchpad is comfortable and the multimedia shortcut keys are perfect if you plan on using the Revo One as an entertainment centre.

We think the free Acer Revo app for iOS and Android is the best option for controlling the Revo One from your sofa. It has an onscreen touchpad for controlling the mouse and lets you use your tablet or smartphone's keyboard for text entry, which is much faster.

While other compact PCs tend to sacrifice storage capacity for smaller dimensions, the Acer Revo One doesn't force you to choose. Performance is respectable and the design, while unorthodox, is attractive as well as clever, giving it the edge over our previous favourite compact system, Scan's 3XS NUC N16 (see *Shopper* 314). If you're looking for a compact PC that will fit comfortably with your living room décor, the Acer Revo One RL85 is one of the best-looking systems we've tested.

Richard Easton

The fact that Acer has made room for three storage disks in a system as small as the Revo One is an impressive feat

review unit came with a single 2TB drive, but the Revo One is available in a multitude of specifications, including an SSD boot drive.

Installing extra disks is easy as well, with a button on the back of the case releasing the outer enclosure. Two flanking hard disk trays then simply lift up and out for adding or removing storage. Accessing the main system disk isn't as straightforward, requiring a screwdriver and a little disassembly, but doing so will let you access the single memory slot.

CHIP SHAPE

There are also plenty of options when it comes to the Revo One's processor. The less expensive models use a dual-core 1.4GHz Intel Celeron 2957U and start at around £239, but there are faster Core i3 versions. Our review model was equipped with a dual-core 1.7GHz Core i3-4005U and 4GB of RAM.

In our demanding application benchmarks, which use 4K resolution video, the Revo One scored

at 1,920x720 resolution, with 4x anti-aliasing and High graphics. If you temper your expectations, however, more casual games such as Minecraft are perfectly playable; here the average frame rate was a smooth 54fps.

CONNECTION POINTS

Despite its compact size, the Revo One doesn't sacrifice connectivity. There are two USB and two USB3 ports on the back, along with HDMI and mini DisplayPort video outputs, a single 3.5mm audio jack and Gigabit Ethernet. Bluetooth and Wi-Fi are built in as standard, but you're limited to 802.11n wireless speeds. You also get a useful SD card reader on the top of the unit.

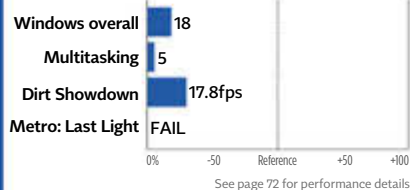
Our review model came with a wireless mouse and keyboard, in colours to match the white unit. Both are very compact, but while the mouse is comfortable to use, the keyboard has some of the spongier keys we've used. It's not something we would want to type long documents on.

Certain configurations



SPECIFICATIONS

PROCESSOR • Dual-core 1.7GHz Intel Core i3-4005U • **RAM** 4GB • **FRONT USB PORTS** None • **REAR USB PORTS** 2x USB, 2x USB3 • **TOTAL STORAGE** 2TB hard disk • **GRAPHICS CARD** Integrated Intel HD 4000 graphics • **DISPLAY** None • **OPERATING SYSTEM** Windows 8.1 • **WARRANTY** One year RTB • **DETAILS** www.acer.co.uk • **PART CODE** DT.SZMEK.014



GAMING LAPTOP

SCAN 3XS Graphite LG157

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VERDICT

Screen and build improvements make this chunky gaming laptop a top mid-range choice

ALMOST ALL THE laptops we review from specialist manufacturers are built using the same unremarkable-looking Clevo chassis, but Scan has switched to a new, overhauled design for the 3XS Graphite LG157. The result isn't eye-popping, but it's thinner, lighter and better made than its predecessors, with a classy, understated design.

A simple 3XS logo on the soft-touch, matt black lid is the only branding present outside, and it's the same once you open the lid. The angled speakers are a nice touch, but lack any real bass or mid-range presence.

There's a numerical keypad in addition to the keyboard, and both are backlit with white LEDs for working in low light. Each full-size key has a satisfying amount of travel, and we didn't have any issues with missed keystrokes. The large touchpad isn't quite as strong; its buttons have a satisfyingly springy action, but the pad itself isn't as responsive as we'd like.

There are ports on almost every edge of the LG157, with four USB3, VGA, DisplayPort and HDMI display outputs, Gigabit Ethernet and three 3.5mm audio jacks for surround sound, which is more than enough for gaming at a desk with a full collection of peripherals. We're baffled as to why there are two memory card slots, however: SDXC is a useful inclusion but few devices use MMC cards any more.

PUNCH THE CLOCK

We had no complaints when it came to performance, thanks to the punchy Intel Core i7-4720HQ processor. This quad-core chip runs at 2.5GHz and is paired with 8GB of 1,600MHz DDR3 RAM, as well as both SSD and hard disk storage. Scan's system configurator lets you add or remove components based on your budget.

The processor is a minor upgrade over last year's i7-4710HQ, and provides performance equivalent to that of a Core i5-powered

desktop PC. It excelled in our benchmarks, managing scores of 112, 88 and 86 in our photo-conversion, video-rendering and multitasking challenges. This laptop is more than powerful enough to tackle moderately challenging tasks in a quick, and mostly quiet, manner. The fans expel air out of the rear of the laptop quietly, and neither the keyboard nor the bottom of the machine get uncomfortably hot while in use.

Nvidia's GeForce GTX 960M graphics card has 2GB of dedicated video memory and, although not a huge upgrade over last year's GTX 860M in terms of raw specifications, proved capable in our tests. Dirt Showdown is unlikely to fluster modern PCs; at 1,920x1,080 resolution and Ultra detail settings, the Graphite LG157 managed a smooth 48fps.

Metro: Last Light Redux provides a bit more of a challenge. Our toughest benchmark takes graphics settings to their highest and switches on the GPU-straining supersampling anti-aliasing (SSAA). In this test, the Graphite LG157 managed 17.7fps, which is too juddery to be considered playable. Switching off SSAA improved this to 33fps, although for a stable frame rate we'd recommend dropping the game's quality settings down from Very High to High, giving the graphics chip a better chance of producing stable gameplay.

Battery life in our moderate usage test was poor at just 4h 20m, and you should expect this to be even shorter if you play games while unplugged. You'll have to take the hefty power brick with you whenever using the

LG157 on the move, but realistically it will be plugged in while gaming at home.

PANEL GAME

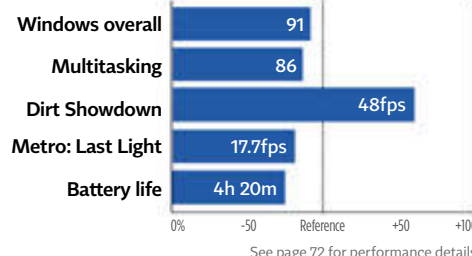
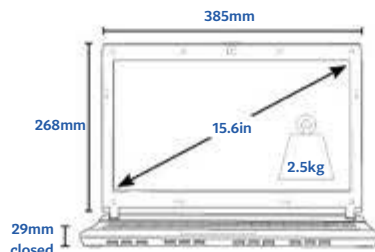
One of the biggest benefits of the new Clevo chassis is an improved display, which switches out the TN panel found in previous 3XS laptops with a superior IPS panel. Resolution remains the same at 1,920x1,080, but in terms of image quality it comfortably beats our current mid-range laptop Best Buy winner, the Acer Aspire V15 Nitro (Shopper 326). An sRGB colour gamut coverage score of 90.9% is among the best we've seen from a Full HD display, while the 862:1 contrast ratio and 0.31cd/m² black levels add up to create vivid and detailed images – particularly important when playing darker games, where some objects and foes are shrouded in darkness.

There's no doubt the Scan 3XS Graphite LG157 is a major upgrade in terms of looks and dimensions over its predecessors, and although the all-black design may be starting to look a little old-fashioned, it's a minor point in what is otherwise a great-value computer. Build quality is high, which isn't always the case when working with Clevo chassis, the components inside are fast and you also get Scan's generous two-year warranty. You can customise almost every aspect of the laptop, too, meaning you can get exactly the specification you want within your budget.

Michael Passingham

SPECIFICATIONS

PROCESSOR Quad-core 2.5GHz Intel Core i7-4710HQ
RAM 8GB
SIZE 385x268x29mm
WEIGHT 2.5kg
SCREEN SIZE 15.6in
SCREEN RESOLUTION 1,920x1,080
GRAPHICS ADAPTOR 2GB Nvidia GeForce GTX 960M
TOTAL STORAGE 120GB SSD, 1TB hard disk
OPERATING SYSTEM Windows 8.1
PARTS AND LABOUR WARRANTY Two years RTB
DETAILS www.scan.co.uk/3xs
PART NUMBER 3XS Graphite LG157



BUDGET 15.6in LAPTOP

ASUS X555LA



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VERDICT

Despite a fair few shortcomings the Asus X555LA is a reasonable budget laptop for those with modest demands

SUB-£400 LAPTOPS don't typically excel at specific tasks but are perfectly capable of basic web browsing, document editing and multimedia playback. The Asus X555LA is one such machine, with a reasonable set of specifications that should suit most everyday needs very nicely – exactly what you want from a laptop at this price.

Build quality is a mixed bag, which will be no surprise to anyone who's used a budget Asus laptop in recent years. The concentric circles surrounding the Asus badge on the lid is a nice touch, as is the lightly dotted texture on the silver keyboard tray, but it all feels distinctly cheap, with a lot of flex in the lid.

There's a fair amount of flex from the keyboard tray too, but it's nowhere near as bad as some of the finger trampolines on some of Asus's older laptops. We found ourselves building up quite a bit of speed on the black chiclet keys. We had no problems with missed keystrokes and were pleasantly surprised by how quiet the keyboard is. The touchpad is responsive too, though Windows 8 gestures such as pinch-to-zoom are a bit clunky and don't feel particularly precise. This isn't exactly out of the ordinary for a budget laptop, though. The touchpad makes a loud and hollow-sounding noise when you click it, which could be irritating if you're working in a quiet place such as a library.

PORT OF CALL

With two USB3 ports on the left and a USB port on the right, there should be ample space for peripherals and storage. HDMI and VGA video outputs make it easy to hook up to a monitor or projector, and there's also a DVD-RW optical drive in addition to an SDXC card reader, so you'll be well served if you have a collection of movies or take a lot of photos. Finally, a 3.5mm combined audio in and out jack is par for the course at this price.



The speakers are also exactly what we would expect from a budget laptop: they might be reasonably loud and there's a tiny hint of stereo separation from the two down-firing tweeters, but music sounds tinny and speech suffers too, somehow sounding significantly quieter than music at the same volume. You'll definitely want to use a pair of headphones with the X555LA.

The screen is a little disappointing, too. The glossy display suffers from glare and reflections when working in direct sunlight or under bright overhead lighting, and there's a noticeable amount of colour shift from the top to the bottom of the screen, even when you're viewing it straight on. The 1,366x768 resolution means objects appear larger than they would on a 15.6in Full HD panel, but it lacks the fine details you'll find on a higher-resolution screen. You also can't comfortably put two windows side by side for multitasking.

FADE TO GREY

The screen covers only 63.7% of the sRGB colour gamut, leaving most colours looking a little washed out. This, paired with a contrast ratio of 373:1, means detail in photographs is left a bit washed out, and the high 0.52cd/m² black levels leave a distinct hint of grey on black onscreen items such as text.

Performance is otherwise fairly sprightly. The X555LA uses a 4th-generation Intel Core i3-4030U processor, a dual-core chip running at 1.9GHz. There's only 4GB of RAM on board,

but as this isn't a laptop aimed at video editors or multitaskers that shouldn't be a major issue. If you want to add more memory, a removable panel on the underside lets you access a single empty RAM slot. This is the only easily accessible part of the interior, and the battery isn't removable, meaning almost complete disassembly to replace the 1TB hard disk.

The X555LA scored 46, 32 and 7 in the single-core image conversion, video-rendering and challenging multitasking test respectively, giving it an overall score of 22. For the purposes of this laptop you should ignore the rather harsh score in the multitasking test as you're unlikely to subject this machine to such intense usage. Actual performance in day-to-day tasks is fine.

LIFE CHANCES

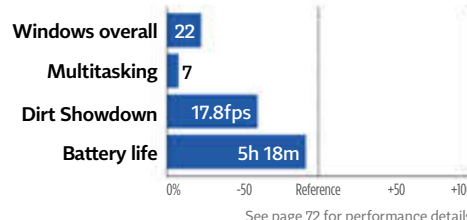
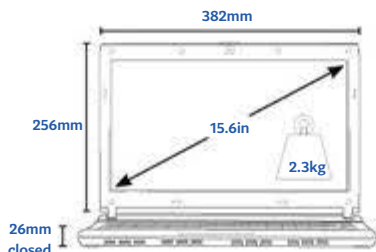
The X555LA also put in a reasonable result in our moderate usage battery test for a budget laptop, lasting 5h 18m. However, it means you won't be able to rely on it for an entire day of working off the grid.

In the end, the Asus X555LA's shortcomings are to be expected for a laptop with such a low price. If you have modest demands and want to spend around £300, it's a decent Windows-powered choice. Toshiba's Chromebook 2 is a viable alternative, costing £50 less with a Full HD display, if you don't mind being restricted to Google's Chrome OS.

Michael Passingham

SPECIFICATIONS

PROCESSOR Dual-core 1.9GHz Intel Core i3-4030U
RAM 4GB
SIZE 382x256x26mm
WEIGHT 2.3kg
SCREEN SIZE 15.6in
SCREEN RESOLUTION 1,366x768
GRAPHICS ADAPTOR Intel HD Graphics 4400
TOTAL STORAGE 1TB hard disk
OPERATING SYSTEM Windows 8.1
PARTS AND LABOUR WARRANTY Two years RTB
DETAILS www.asus.com/uk
PART NUMBER X555LA-XX290H





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VERDICT

Battery life is disappointing, but for the price you get a useful camera and a great screen

FEW PHABLETS COME close to matching the speed, gorgeous screen or long battery life of Samsung's Galaxy Note 4, but you pay a fortune to own one. Big-screen phones at the budget end of the market rarely stand up to scrutiny, but HTC's Desire range continues to buck that trend. The latest, the Desire 820, is one of the best yet.

The Desire 820 takes several design cues from the Desire Eye, with a gorgeous dual-colour unibody design. There's not a single break in the handset, despite the multiple colour highlights, as HTC has injected the secondary colour directly into the phone's soft touch surround for a near-seamless finish. The handset feels incredibly well made as a result, and we particularly like the grey and orange colour scheme of our review sample.

The bezels are rather chunky, and the soft touch rear and rounded corners can be a little slippery at times, particularly if you're only using one hand, but on the whole we found it very easy to use.

The Desire 820's 5½in display isn't the sharpest we've seen with its lowly 1,280x720 resolution, but its 267 pixels per inch mean text is perfectly legible and icons are largely free from jagged edges. You can see some jaggedness up close, but at a normal viewing distance we had no complaints.

Picture quality was decent, too: colour accuracy was actually better than on HTC's flagship One M9. Compared with the One M9's 87.1% sRGB colour gamut coverage, the Desire 820's 90.8% coverage resulted in slightly more authentic colours. Red was a little lacking but the rest of the primary colours were spread evenly across the gamut, producing balanced, natural-looking images.

BEYOND THE PALE

The high 440.69cd/m² brightness produced lovely clear whites and made the screen easier to see outside. This made blacks appear quite grey, measuring 0.41cd/m², but this didn't have too negative an effect on contrast levels. With its contrast ratio of 1,060:1, images still had plenty of detail and the screen rarely darkened when we weren't looking at it face on.

An eight-core, 1.7GHz Snapdragon 615 processor and 2GB of RAM give the Desire 820 a power boost over last year's equivalent. The 64-bit chip will be more important when the Desire 820 is upgraded to Android 5.0, but for now it runs Android 4.4.

We were particularly impressed with its web



browsing capabilities, as its score of 1,492 in Browsermark comfortably beats the Huawei P8's 1,108. The difference was obvious when we compared both phones side by side. The P8 was noticeably jerky when scrolling, but the Desire 820 was virtually judder free, providing a smoother and less frustrating web experience than its pricier rival.

The Desire 820's processor wasn't as fast in our Basemark OS II benchmarks, but its score of 735 is perfectly decent for a phone at this price. You needn't worry about its graphics capabilities either, as it handled our Basemark X 1.1 graphics tests surprisingly well. With an overall score of 10,236, it produced an average of 18.2fps in the Dunes test and 26.1fps in the Hangar test. That's not quite fast enough to play games at the very highest quality settings, but it's more than adequate to run 3D games relatively smoothly.

Unfortunately, the Desire 820's processor takes its toll on the 2,600mAh battery, which lasted just 9h 18m in our continuous video playback test. You'll get a full day's use out of it, but it can't quite match last year's Desire 816, which had a battery of the same size and lasted 10h 49m in the same test.

AUTO COMPLETE

The 13-megapixel rear camera is unchanged from the Desire 816, but image quality hasn't decreased. There was plenty of detail across the frame in outdoor shots, and colours were bright and punchy. We noticed a tendency toward slight overexposure on lighter objects, but overall we were pleased with the quality of its shots in Auto mode. Switching to HDR mode helped even out the contrast and brought some much needed relief to the slightly dark shadow areas.

Battery life may not be as good as its predecessor's, but in every other respect the Desire 820 is easily the superior handset. With its decent screen, excellent performance and capable camera, it's one of the best budget phablets available today – even if it does use the slightly old fashioned looking Sense 6 UI.

Katharine Byrne

SPECIFICATIONS

PROCESSOR Quad-core 1.7GHz & quad-core 1GHz Qualcomm Snapdragon 615 • **SCREEN SIZE** 5½in • **SCREEN RESOLUTION** 1,280x720 • **REAR CAMERA** 13-megapixel • **STORAGE** 16GB • **WIRELESS DATA** 3G, 4G • **SIZE** 158x79x7.7mm • **WEIGHT** 155g • **OPERATING SYSTEM** Android 4.4.4 • **WARRANTY** One year RTB • **DETAILS** www.htc.com • **PART CODE** Desire 820



See page 72 for performance details

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VERDICT

With its gorgeous screen, versatile camera and surprisingly comfy leather rear, the LG G4 is a genuine alternative to the Samsung Galaxy S6

2015 LOOKED LIKE the beginning of the end for plastic smartphones, with both HTC and Samsung opting for metal and glass, but LG has gone down a different route. The G4 has gone full leather, using vegetable-tanned, full-grain cow hide on the rear to set it apart.

The stitching down the centre is a classy touch, and the smooth tan leather provides excellent grip. It's not the slimmest phone, but LG says customers were willing to put up with a few extra millimetres for a more ergonomic design – and we're inclined to agree. Leather adds £20 to the handset price, however, which makes a 32GB leather-backed G4 £20 more expensive than a 32GB Samsung Galaxy S6.

The plastic 'ceramic' and 'metallic' variants of the G4 are cheaper, costing around £530 SIM-free. Our white ceramic model had a subtle diamond pattern on the back, which adds a bit of flair. In the hand it feels almost identical to the G3, though, and it isn't as attention-grabbing as the leather-backed G4. All models have a removable back, which reveals the battery and a microSD card slot.

SLEEPY HOLLOW

Technically, the front of the screen curves inwards, but the arc is so small you'll barely notice it unless you lay the phone on a flat surface. It's nowhere near as curvy as LG's G Flex 2, but the curve should help protect the screen if it falls face-down on the floor.

The G4's 5½in, 2,560x1,440 display isn't the sharpest around now that Samsung has squeezed the same resolution into the 5.1in Galaxy S6, but LG's IPS Quantum panel promises better brightness and colour accuracy. In practice, the screen displays rich, vibrant colours and eye-searingly bright whites. It's almost comparable with OLED for sheer colour intensity, but the G4's higher brightness level of 505.66cd/m² keeps colours looking punchy outside as well as indoors. Blacks were deep at 0.27cd/m² and we were impressed with the G4's 1,715:1 contrast ratio.

According to LG, the G4 is the only smartphone to cover 98% of the Digital Cinema Initiative (DCI) colour gamut, which

equates to around 120% of the sRGB gamut. Our colour calibrator measured only 96.3% of the sRGB colour gamut, but this is still respectable for an IPS screen, even if it doesn't quite live up to LG's promises.

The G4's other headline feature is the 16-megapixel rear camera, which is paired with a colour spectrum sensor that LG claims interprets colours in the same way as the human eye. It reads both the RGB spectrum and infrared, adjusting white balance automatically to make objects look more lifelike.

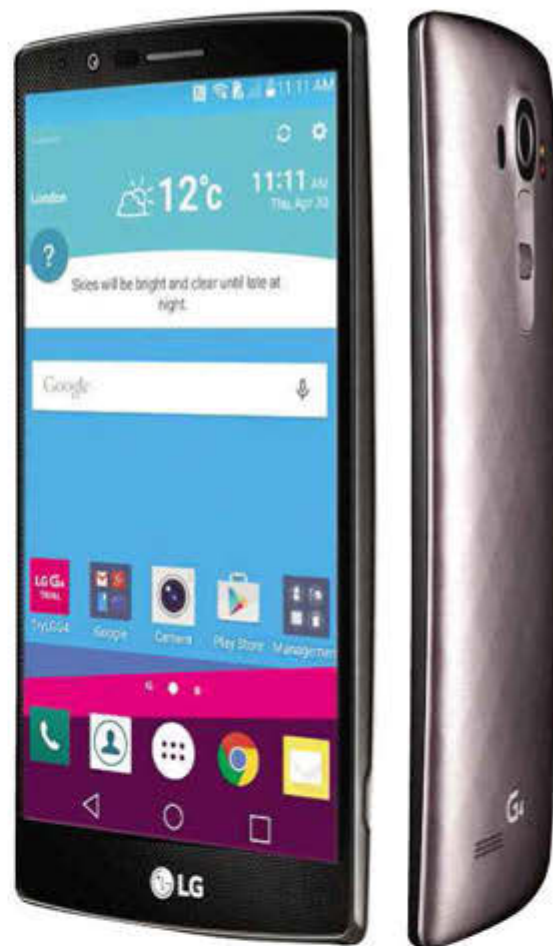
This, combined with a wide f/1.8 aperture for letting in more light, improved optical image stabilisation, and the return of the laser autofocus last seen on the G3 resulted in impressive levels of detail in outdoor shots. It struggled to expose areas of bright cloud correctly at times, but switching to HDR mode sorted this out.

The real star is the new Manual mode, which lets you adjust white balance, shutter speed and ISO live onscreen. With these flexible controls you can be a little more creative with your photography. Shutter speed times reach all the way up to 30 seconds, so you can take arty shots of cityscape light streams and waterfalls. Photography enthusiasts will be grateful for the addition of Raw support too.

LG has used the six-core 1.8GHz Snapdragon 808 chip for the G4 rather than the Snapdragon 810 found in other flagship phones, and its 3GB of RAM is more than enough to handle multiple apps at once. In our Basemark OS II benchmarks, the G4's overall score of 1,502 sits comfortably between the Snapdragon 810-powered HTC One M9's score of 1,463 and the Galaxy S6's 1,643. The G4's Browsermark score of 1,919 is also high, and web browsing was beautifully smooth with no judder.

The G4 fell behind in our Basemark X 1.1 graphics benchmarks, however, scoring 24,998 at Medium quality settings, with averages of 23.9fps in the Dunes test and 31.9fps in the Hangar test. The HTC One M9 scored 28,074 overall, but even that is outclassed by the Galaxy S6's massive 31,157. In real use, though, the G4 is more than capable of playing complex 3D games.

We'd hoped for a little more from the G4's 3,000mAh battery, but 11h 58m of video playback with the screen set to



170cd/m² is still a pretty decent score. This compares well with the Galaxy S6, which lasted 13h 37m under the same conditions.

The G4 runs Android 5.1 with LG's new UX 4.0 interface over the top; it's clean, flat and in keeping with Google's Material Design scheme, and we like the way its Smart Notices have been integrated with the main clock and weather widget on the main homepage. LG's Knock Code also returns, letting you tap out a specific pattern on the screen, even when the display is turned off, to unlock your phone.

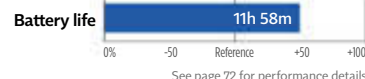
HIDE AND SEEK

While we're not particularly keen on the ceramic or metallic models, the leather-backed G4 is surprisingly elegant, and we prefer it to the slippery glass Galaxy S6. Its camera is neck and neck with the S6's for image quality and its display looks just as good as Samsung's AMOLED panels. We'd say it's a genuine alternative to either of Samsung's flagship handsets, and we'd definitely choose a G4 over an HTC One M9.

Katharine Byrne

SPECIFICATIONS

PROCESSOR Hexa-core 1.8GHz Qualcomm Snapdragon 808
SCREEN SIZE 5½in • **SCREEN RESOLUTION** 2,560x1,440 •
REAR CAMERA 16-megapixel • **STORAGE** 32GB •
WIRELESS DATA 3G, 4G • **SIZE** 149x75x8.9mm • **WEIGHT** 155g • **OPERATING SYSTEM** Android 5.1 • **WARRANTY** One year RTB • **DETAILS** www.lg.com • **PART CODE** LG-F500L



MICROSOFT Lumia 640/ Lumia 640 XL

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VERDICT

The Lumia 640 XL brings Windows Phone phablets back from the dead. The smaller Lumia 640 is less impressive but still good value

THE LUMIA 535 was the first phone to bear Microsoft's name after the company bought Nokia, but it was such a disappointment that we were worried we'd never see a decent Lumia Windows phone ever again. Since then, Microsoft has clearly got its act together as the colourful Lumia 640 and larger Lumia 640 XL are some of the best-value Lumia phones we've seen in a long time.

The Lumia 640 a big step up from its 4½in predecessor, the Lumia 630, as it has a huge 5in screen with a 1,280x720 resolution. Meanwhile, the Lumia 640 XL's 5.7in display is a lot more manageable than the 6in Lumia 1320 and 1530. Both versions of the Lumia 640 are built to an excellent standard, with angular edges that let you grip them securely. The 640 XL is slightly fatter at 158x81x9.0mm to the 640's 141x72x8.8mm, though, and reaching across the screen can be a bit of a stretch when using the phone single-handed.

DOC AND COVER

The Lumia 640 XL features a number of upgrades over the 640 to justify the higher price. The most obvious is the larger 5.7in display, which is great for web browsing and composing Office documents. Microsoft is throwing in a year's free subscription to Office 365 and 1TB of OneDrive cloud storage with every handset, which you can also use on your PC and Windows tablets.

Both phones have the same 1,280x720 resolution, which means the 640 XL's screen isn't as sharp as the 5in 640's, although from a normal viewing distance we couldn't really tell the difference. Peering in close revealed marginally more jagged letters and icons on the bigger handset, but everything was still perfectly legible and it didn't cause any problems during everyday use.

Microsoft's ClearBlack IPS displays help create inky blacks that look deeper than the measured levels of 0.34cd/m² for the 640 and 0.52cd/m² on the 640 XL would suggest. The Start screen's deep black background almost blends seamlessly into the surrounding bezels.

The 640 XL's screen is significantly brighter than the 640's – an incredible 581.79cd/m² compared with 376.11cd/m² at the highest brightness settings – and also more accurate. According to our colour calibrator, the 640 XL displayed 93.2% of the sRGB colour gamut as opposed to just 90.7% for the 640, and its coverage was spread more evenly across the gamut, resulting in richer, more natural-looking images.

Contrast is a little low on the Lumia 640 at 833:1, but this is to be expected on a lower-end phone, and plenty of detail was visible in our test images. The 640 XL has a better contrast ratio of 1,102:1. Viewing angles are also much wider, and we were able to see the screen clearly from a range of positions.

BUILT TO LAST

We were pleased to see that the Lumia 640's screen didn't put too much of a strain on the 2,500mAh battery. Its score of 10h 11m in our continuous video playback test is more than acceptable for such a cheap handset. The Lumia 640 XL lasted an impressive 14h 45m, thanks mainly to its bigger 3,000mAh battery. It's one of the best results we've seen from a Lumia phone and should provide more than enough juice to get you through the day.



Inside, the Lumia 640 and 640 XL share identical components, including a quad-core 1.2GHz Qualcomm Snapdragon 400 processor and 1GB of RAM. We're a little disappointed that Microsoft chose this over the newer, faster Snapdragon 410 chipset, but both phones are quick enough for everyday tasks.

The Lumia 640 scored only 510 in our Browsermark test, while the 640 XL scored 627, but in practice we had few complaints when browsing the web on either device. There was sometimes a second's delay when loading pictures but scrolling was judder-free, ensuring a very smooth browsing experience.

We weren't particularly impressed with the murky images we captured with the Lumia 640's 8-megapixel camera, but the 640 XL's larger 13-megapixel sensor is far more capable, producing bright, crisp images without a hint of haze or blurry edges. Shadows could be a little dark, but plenty of fine detail was present and we couldn't see many traces of noise, even in large expanses of sky.

The Lumia 640 XL has proven a worthy successor to the Nokia phones of old. Its superior battery life and capable camera make it a brilliant travel companion, and its big screen arguably makes Microsoft's Office 365 offer even more useful, as it provides more space for editing your documents.

Such a big handset won't be for everyone, but the Lumia 640 fills that gap nicely. With a great-looking screen and snappy performance, it clearly punches above its weight for an entry-level handset. The inclusion of 4G is a surprise given the phone's quality and price.

The Lumia XL costs £46 more, but if you have the budget and you want a phone that can go the distance, the Lumia 640 XL is an excellent choice, and it also supports 4G.

Katharine Byrne

SPECIFICATIONS Lumia 640

PROCESSOR Quad-core 1.2GHz Qualcomm Snapdragon 400
SCREEN SIZE 5in • **SCREEN RESOLUTION** 1,280x720 •
REAR CAMERA 8-megapixel • **STORAGE** 8GB • **WIRELESS DATA** 3G, 4G • **SIZE** 141x72x8.8mm • **WEIGHT** 145g •
OPERATING SYSTEM Windows Phone 8.1 • **WARRANTY** One year RTB • **DETAILS** www.microsoft.com • **PART CODE** RM-1072

Battery life



See page 72 for performance details

SPECIFICATIONS Lumia 640 XL

PROCESSOR Quad-core 1.2GHz Qualcomm Snapdragon 400
SCREEN SIZE 5.7in • **SCREEN RESOLUTION** 1,280x720 •
REAR CAMERA 13-megapixel • **STORAGE** 8GB • **WIRELESS DATA** 3G, 4G • **SIZE** 158x81x9mm • **WEIGHT** 171g •
OPERATING SYSTEM Windows Phone 8.1 • **WARRANTY** One year RTB • **DETAILS** www.microsoft.com • **PART CODE** RM-1066

Battery life



See page 72 for performance details

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VERDICT

Dependable and feature-rich, but the Panasonic GF7 is beaten by cheaper rivals

THE GF7 IS the sixth generation of Panasonic's entry-level compact system camera. It's not quite the smallest – the GM5 (see *Reviews, Shopper 329*) takes that accolade – but at 341g and 62mm deep with its kit lens, it's hard to imagine anyone rejecting it for being too bulky.

This is thanks in part to the slimmer lens, which we've seen on the GM5 but wasn't included with the GF6 (see *Reviews, Shopper 310*). There's no focus ring, leaving manual focus to the rear buttons, but it's amazingly slim for a lens with a mechanical zoom. Other slim zoom lenses use a motorised zoom, which we don't find as satisfying to use.

The body is slimmer and 57g lighter than the GF6's, but battery life has fallen from 330 shots to 230 as a result. The flash is weaker too at just GN4 at ISO 100. That equates to just 1.6m at f/3.5 before the ISO speed must increase from its base ISO 200 setting.

SHRINK RAP

Another casualty of miniaturisation is the shutter. The GF7 uses a mechanical shutter with an electronic front curtain, but for shutter speeds beyond 1/500s it uses a full electronic shutter. As the sensor takes measurements row by row from the top to the bottom, this can skew the geometry in fast-moving images – known as rolling shutter. It's hardly a disaster but the GF7 wouldn't be our first choice for fast-moving subjects.

The design has had a significant overhaul, with a more angular, retro appearance, but

the silver top plate is made from plastic rather than metal and the GF6's slender handgrip has disappeared. The leather-effect finish means it's not too slippery in the hand but there's very little to hold on to. As with the GF6, the articulated screen can tilt up and over for self-portraits, but can't tilt down for overhead shots.

This may be an entry-level model but we're happy to see a dedicated mode dial, with access to priority and manual exposure modes. The rear wheel makes adjusting settings quick, and the excellent touchscreen interface places the key functions within easy reach. The touchscreen is particularly useful for autofocus control, with the ability to vary the area size and place it anywhere in the frame. As usual for Panasonic CSCs, a dedicated iA button puts the camera into fully automatic mode, regardless of other settings. However, we're baffled by the Record Settings Reset button located behind the screen. It's a feature we hardly ever feel the need to use so it really doesn't require a dedicated button.

There are fun shooting modes including panoramas, HDR, time-lapse and stop-motion animation. Wi-Fi is implemented well, with companion iOS and Android apps offering comprehensive remote control. We also like the ability to transfer to a shared folder on a PC over a home network, with the camera storing connection settings as a preset.

MOTION SICKNESS

Lumix G cameras usually excel at video, but the GF7 is the first we've seen in a while that lacks manual exposure controls. You can't even lock or adjust exposure compensation while recording. We also found that the microphone sounded a little tinny. At least the autofocus controls remain accessible, and the GF7 exhibits Panasonic's usual high standards for video picture quality. It's an excellent video camera for casual use.

There's no dent to Panasonic's reputation for performance. The GF7 switched on and captured a photo in one second. Fast autofocus contributed to a speedy 0.5 seconds between shots in normal use. Continuous shooting was at 5.4fps for 50 frames before slowing to

4.2fps, and it managed 4.2fps with continuous autofocus. Raw capture was at 4.7fps for nine frames, slowing to 1.7fps.

Image quality showed a small improvement over the GF6 for noise at ISO speeds above 3200, but the GF7 still trailed behind CSCs from Sony, Samsung and Fujifilm that use physically larger sensors. The differences aren't huge though. The GF7 did an excellent job of retaining details in dimly lit shots but skin tones tended to look a little scruffy.

It excelled in brighter conditions. The JPEG engine extracted every last drop of detail from the 16-megapixel sensor, and with an impressively sharp kit lens, the GF7 more than holds its own with 24-megapixel rival CSCs. Colours were balanced and natural, and selecting Intelligent ISO meant the camera automatically raised shutter and ISO speeds to avoid motion blur in moving subjects.

There's little to fault with the GF7. It's petite, responsive and easy to use, includes some fun shooting modes and takes excellent photos and videos. The battery life is disappointing, but our biggest issue is the price. Rival CSCs such as the Sony A5000 (see *Reviews, Shopper 320*) and Samsung's NX3000 (*Shopper 323*) cost significantly less.

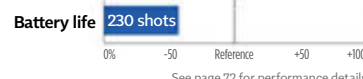
The GF7 isn't a huge upgrade over the GF6, which is still available for £219 from Jessops. It's not always fair to compare new models to discounted previous ones, but the longer battery life, mechanical shutter and more versatile screen articulation can't be ignored. It's worth keeping an eye on the GF7's price but we wouldn't spend £400 on it.

Ben Pitt



SPECIFICATIONS

SENSOR RESOLUTION 16 megapixels • **SENSOR SIZE** 17.3x13mm • **FOCAL LENGTH MULTIPLIER** 2x • **VIEWFINDER** None • **LCD SCREEN** 3in (1,040,000 dots) • **OPTICAL ZOOM (35mm-EQUIVALENT FOCAL LENGTHS)** 2.7x (24–64mm) • **35mm-EQUIVALENT APERTURE** f/7–11.2 • **LENS MOUNT** Micro Four Thirds • **WEIGHT** 341g • **SIZE** 65x114x62mm • **WARRANTY** One year RTB • **DETAILS** www.panasonic.com



NIKON D7200

COMPUTER
SHOPPER
BEST BUY£849 inc VAT (body only) • From www.jessops.com

VERDICT

Best-in-class image quality and sublime ergonomics take the Nikon D7200 to the top of the pack

WITH BIG VIEWFINDERS, sophisticated autofocus and metering systems, lots of physical controls and superb ergonomics, Nikon's 7000-series cameras have always been ideal for photographers who want professional-level features but can't justify the cost of a full-frame digital SLR. Two years after the launch of the D7100 (see *Reviews, Shopper 308*), our first impression of the D7200 is that little has changed.

The two cameras look identical except for the name badge, Wi-Fi and NFC logos, although the layout of the D7100's controls was superb so there's no reason to change a winning formula. There's no dedicated Wi-Fi button, but enabling this in the menu is easy, and phones with NFC can be held up to the side of the camera to establish a connection.

Nikon's iOS and Android apps are simple but effective. Thumbnails are transferred on connection for browsing, and photos can be transferred at full, 2-megapixel or VGA resolution. The remote viewfinder mode offers only a shutter release and touchscreen autofocus, but that's enough for self-portraits.

INNER STRENGTH

There are lots of improvements under the bonnet. Battery life has increased from 950 to 1,100 shots, 60fps video capture is available at 1080p, and there's a larger buffer for longer burst sequences. The autofocus sensor retains its 51-point array but it's now sensitive down to -3 EV compared with the D7100's -2 EV. The ISO range has increased by two stops as well, although the highest 512,000 and 1,024,000 settings are black and white only.

Nikon's controls have always lent themselves to two-handed use. Hold down a button to the left of the screen and the dual

command dials are reassigned accordingly. This technique isn't ideal when supporting a heavy telephoto lens, but otherwise we find it easier than Canon's right hand-only approach, which can be fiddly.

The D7200's top-mounted passive LCD screen doesn't show white balance or JPEG/Raw quality settings during adjustment – instead the rear screen lights up. The viewfinder shows exposure-related settings, autofocus mode, focus point and remaining memory capacities, but for other settings you'll again need to look at the rear screen.

Auto ISO is now available in Manual exposure mode, which lets you set aperture and shutter speeds manually while keeping exposure controlled automatically via the ISO speed – a particularly useful feature for video capture. Videographers will also appreciate the Flat Picture Control preset, which provides a useful starting point for colour grading. Finally, a dedicated menu tab for the Movie mode makes settings easier to find and allows settings and button assignments to be made independently for photo and video capture.

CROP ROTATION

1080p video at 60fps is available only when a 1.3x crop is selected, and recording time falls from 20 to 10 minutes per clip. The 60p option is simply greyed out until the sensor crop is adjusted elsewhere in the Menu, but there are no clues to help users. Video picture quality is excellent, with flattering colours and crisp details, but the clumsy autofocus is suitable only for casual use. We can't imagine serious videographers choosing the D7200 over the Panasonic GH4 (see *Reviews, Shopper 318*).

We were impressed by how well the autofocus coped with gloomy, indistinct subjects. The time between pressing the shutter button and capturing a photo was between 0.1 and 0.3 seconds, except in exceptional circumstances. This contributed to the D7200's ability to capture a photo every 0.25 seconds in normal use – almost twice as fast as the D7100.



Whereas the D7100's 6fps continuous shooting mode lasted for 18 JPEGs or five Raw frames, the D7200 captured 48 JPEGs and 13 Raw frames before slowing to the speed of the card. The highest-quality 14-bit Raw files are limited to 5fps capture, however, with 6fps only available for 12-bit Raw.

The two cameras were level pegging for detail and dynamic range, both for JPEG and Raw output. As we raised the ISO speed, it was hard to separate them for noise levels in Raw files, but the D7200 showed a marked improvement in the appearance of its JPEGs. The D7200 even outperformed the full-frame Nikon D610 for noise in JPEGs, although it couldn't match it for Raw output. Anyone who spends this much on a camera and who really cares about image quality will probably be shooting Raw, but it's reassuring that quality won't suffer if you switch to JPEG.

The D7200 may lack headline-grabbing new features but it improves on the D7100 in areas that make a genuine difference, such as more responsive autofocus in low light and more sustained continuous shooting. 4K video and an articulated screen would have raised the stakes for video, but photographers are unlikely to miss these features.

At £849 for the body only, it costs more than Canon's EOS 70D (see *Reviews, Shopper 311*) but considerably less than the £1,400 EOS 7D Mk II. The Nikon takes the edge for image quality, with sharper details at low ISO speeds and a more marked advantage at high ISO speeds. There are few bells and whistles, but the D7200 is superbly designed to let photographers get the photos they want.

Ben Pitt

SPECIFICATIONS

SENSOR RESOLUTION 24 megapixels • **SENSOR SIZE** 23.5x15.6mm (APS-C) • **FOCAL LENGTH MULTIPLIER** 1.5x
• **VIEWFINDER** Optical TTL • **LCD SCREEN** 3.2in (1,229,000 dots) • **LENS MOUNT** Nikon F Mount • **WEIGHT** 765g
• **SIZE** 107x136x76mm • **WARRANTY** Two years RTB
• **DETAILS** www.europe-nikon.com • **PART CODE** D7200



See page 72 for performance details



PREMIUM COMPACT CAMERA

FUJIFILM XQ2



£279 inc VAT • From www.currys.co.uk

VERDICT

The XQ2 strikes an excellent balance between image quality, compactness and price

THE XQ2 MAY look like a typical compact camera but it shouldn't be underestimated. The two most significant specifications for image quality are sensor size and lens aperture, and the XQ2 ups the ante for both.

The sensor measures $\frac{2}{3}$ in from corner to corner, with twice the surface area of the usual $\frac{1}{2}$ in sensors. Meanwhile, the f/1.8 lens is four times brighter than a typical f/3.3 lens. That means eight times the light gathering ability of a conventional compact camera.

The caveat is that the XQ2's aperture quickly narrows as it zooms in: f/1.8 at 25mm is fantastic but f/3.6 at 35mm and f/4.9 at 100mm are less so. Other premium compacts maintain a wider aperture throughout their zoom range, such as the Canon G7 X (see *Reviews, Shopper 327*) with its f/1.8-2.8 lens. The G7 X has a bigger 1in sensor too, but it's also bulkier and pricier, so the XQ2 strikes an appealing balance.

The design is simple and smart, if not quite as satisfying as the Fujifilm XF1's (see *Reviews, Shopper 304*), which came before it. The XF1 had similar specifications but included a mechanical lens ring to adjust the zoom, which doubled as a power switch when the lens was retracted inside the camera. The XQ2 has a more conventional power button and zoom lever. There's a lens ring that can be assigned to zoom or other functions, but it's less responsive as a mechanical control. Elsewhere there's a mode dial, rear wheel and basic collection of buttons. Pressing E-Fn reassigns six buttons to various functions. These can be customised from a choice of 14 options including ISO speed, autofocus area and drive mode. The controls work well enough but they don't have the same tactile efficiency of pricier premium compacts.



Wi-Fi is built in, and the accompanying iOS and Android apps support wireless transfers managed either on the camera or the connected device. There's an option to use a smartphone's GPS radio to geotag photos but it's more hassle than it's worth, and there's no option to take pictures remotely. We initially struggled to get the camera to talk to our Android smartphone, until we realised that we needed the Fujifilm Camera Application app rather than the Fujifilm Camera Remote, which isn't compatible with the XQ2.

LIGHT SPEED

Fujifilm makes grand claims about the XQ2's autofocus speed, with phase detection points built into the sensor to focus in just 0.06 seconds. In our tests it took between 0.3 and 0.4 seconds to capture a photo – not as dramatic as the claims but still excellent. Shot-to-shot times were 0.6 seconds for JPEGs and 0.5 seconds for Raw. Continuous JPEG shooting was at an impressive 10.8fps for 11 frames, slowing to 3.6fps. Raw capture was at 8.9fps for eight frames, slowing to 1.8fps. These are superb results, and contribute to the impression of an upmarket camera.

Fujifilm cameras tend to fall short for video quality, and the XQ2 is no exception. The specs look promising, with 1080p capture at 30fps and 60fps in AVC format, but footage suffered from noise and blocky details. Autofocus was skittish and the autofocus motor disrupted the soundtrack.

Still images were considerably better. Shots taken in automatic mode were expertly exposed, and we were impressed to see the camera raising the shutter speed for moving subjects. You can also customise the Auto ISO function to set a maximum ISO and minimum shutter speed. Detail levels were good rather than great, with a slightly vague appearance to dense textures such as foliage. The 12-megapixel resolution is modest by today's standards but unless you print A4 photos or crop heavily, it's unlikely to be an issue. We noticed a halo around highlights but, again, it was subtle enough not to be a real problem.

NOISE POLLUTION

Noise levels are the toughest challenge for a compact camera. The XQ2's f/1.8 lens really paid off in wide-angle shots but noise shot up as we zoomed in. Then again, knowing this we were able to take good shots by repositioning ourselves rather than relying on the zoom.

The XQ2 adds up to a great package, and although spending £66 more on the Canon G7 X gives a jump in quality, we suspect many people would prefer to spend under £300 and go for something truly pocket sized. However, it's worth noting that image quality hasn't progressed significantly since the XQ1 and XF1, which are available at knock-down prices. We'd also seriously consider the Panasonic LX7 (see *Reviews, Shopper 298*), which costs around £280 and is still an excellent choice despite its age. The XQ2 is slimmer and lighter, though, and its built-in Wi-Fi is another advantage over the LX7. It's a great choice.

Ben Pitt



SPECIFICATIONS

SENSOR RESOLUTION 12 megapixels • **SENSOR SIZE** $\frac{2}{3}$ in • **VIEWFINDER** None • **LCD SCREEN** 3in (920,000 dots) • **OPTICAL ZOOM (35mm-EQUIVALENT)** 4x (25-100mm) • **35mm-EQUIVALENT APERTURE** f/7-19 • **WEIGHT** 208g • **SIZE** 60x108x33mm • **WARRANTY** One year RTB • **DETAILS** www.fujifilm.eu/uk • **PART CODE** Fujifilm XQ2

Battery life 240 shots

0% -50 Reference +50 +100

See page 72 for performance details

OFFICE PROJECTOR

VIEWSONIC PJD6352



£442 inc VAT • From avpartsmaster.co.uk

VERDICT

Vibrant colours and compact size from this competent – if rather loud – office projector

THIS COMPACT OFFICE projector is ideal for use in smaller rooms, and at 316x228x104mm and 2.2kg it's easy to take on the move. The chassis is best described as plain, with a brushed black plastic exterior. The manual focus and 1.51-1.97m throw adjustment wheels produce a large image from a distance of around two metres. Vertical and horizontal keystone adjustment and a height-adjustable foot on the front make it easy to obtain a perfect rectangular projection without too much effort, although using digital keystone degrades the picture compared with setting the device face-on to the projection surface.

TOP TRUMPS

Buttons on the top control basic functions including keystone correction and colour adjustment, and there's a small remote control with buttons for freezing the screen, accessing the menus and changing source. If your smartphone is on the same network as the projector – which you have to plug in through the LAN port – you can control it using the vRemote app for Android and iOS.

Two VGA inputs and one output, two HDMI ports – one with MHL support for mirroring a smartphone or tablet on the projector – S-video and composite video inputs, two 3.5mm audio inputs and a single 3.5mm output should be more than enough to connect your devices, no matter how old they are. There's also a serial port, LAN connector and a Mini USB port for controlling presentations using buttons on the remote.

The MHL port is hidden behind a panel on the side of the projector, which also has space for the optional WPG-370 wireless dongle. At £149, this is an expensive extra, but it lets you project wirelessly from PCs, laptops and handhelds using Miracast.

The PJD6352 is a DLP projector, which means it uses a spinning colour wheel to project colour images. The lamp is bright enough for daylight use at 3,500 lumens, and images looked bright and vibrant when the lights were switched off, with crisp colours and inky text. The 4:3 aspect ratio is good enough for projecting presentations and documents but less suitable for widescreen video. Resolution is also disappointingly low for the price at just 1,024x768.

Of the five colour modes available – Standard, ViewMatch, Dynamic, Movie and Brightest – we found that Dynamic produced the most natural colours. It also made adjustments when the screen was filled with bright whites that could dazzle some onlookers. We'd suggest avoiding the Brightest and Standard settings, as they give colours a strange, slightly filtered appearance that looks unnatural and not particularly pleasant. Movie mode is dimmer and adds a slightly blue tint, but the effect is subtle. The 2,400:1 native contrast ratio was good enough to do justice

to most of our test images, although those with very dark areas became fairly hard to see.

There's no frame interpolation when watching videos, which means rapid vertical and horizontal movement results in some juddering. This won't be too much of a problem if the PJD6352 will be relegated to office work, but it's annoying if you want a projector that can double as a home cinema device.

The 10W speaker is no substitute for a set of dedicated speakers, but it's perfectly acceptable for speech and background music. We'd recommend not setting it to Speech mode, though, as this produces ear-piercingly loud and unpleasantly harsh high-frequency noises.

It's just as well the speaker is loud, because the internal fan makes a racket. This falls to 27dB in Eco mode, but you sacrifice image brightness as a result. Either way, it could be distracting if the projector is in the middle of a conference table rather than ceiling mounted.

The lamp is rated to last for 4,000 hours, although Eco mode raises this to 10,000 hours, which should help keep running costs down. There aren't any dust filters to replace either.

The ViewSonic PJD6352 may not have the highest of resolutions, but its bright lamp, compact size, network connectivity and reasonable price make up for this – as long as your needs are modest. Our biggest gripe is the noisy fan. If you want something even more compact, the tiny Pico Genie M100 is perfect for presenting on the move.

Michael Passingham



SPECIFICATIONS

PROJECTOR TYPE DLP • **NATIVE RESOLUTION** 1,024x768 • **VIDEO INPUTS** 2x VGA, 2x HDMI (1x MHL), composite, S-video • **LAMP LIFE** 4,000h • **LAMP BRIGHTNESS** 3,500 lumen • **SIZE** 104x316x228mm • **WEIGHT** 2.2kg • **WARRANTY** Three years collect and return • **DETAILS** viewsoniceurope.com • **PART CODE** pjd6352

CONNECTION PORTS

VGA x2

HDMI x2

Composite

S-video

GAMING MONITOR

BENQ RL2755HM



£210 inc VAT • From www.scan.co.uk

VERDICT

This display for console gamers can't deliver the image quality we'd expect at this price

BENQ'S RL MONITOR range is aimed primarily at gamers, with reasonably priced panels that cost only slightly more than their non-gaming equivalents. BenQ wants the RL2755HM to tempt console gamers away from their TVs, which are lumbered with relatively lethargic response times in comparison with a decent gaming monitor.

The 27in RL2755HM is somewhat underwhelming from a technical standpoint, with a mere Full HD resolution and 60Hz refresh rate, although admittedly these specifications match the capabilities of the current console generation. Its design is, for the most part, fairly standard too, with textured black plastic on the monitor frame, a glossy material on the back and a few red highlights on the base and rear.

BenQ has made a couple of gamer-specific design tweaks, though. A flip-out lever on the back at the left of the monitor provides a hanger for headphones and is big and sturdy enough to hold even the heaviest of gaming headsets. However, there's no indication on the front of the monitor as to how high up the screen the lever is, so you might be left scrabbling around to find it at the end of a gaming session.

BenQ wants the RL2755HM to tempt console gamers away from their TVs, which are lumbered with relatively lethargic response times in comparison with a decent monitor

The angled base is covered with a thin swathe of rubber material, which gives your controllers something to grip on to rather than leaving them lying around and taking up desk space. Sadly, the base offers no height adjustment or rotation, which would have been particularly useful for gamers who sometimes sit back when playing and then hunch forward when they're concentrating.

The monitor's physical additions don't quite hit the mark, then, but the generous array of inputs is welcome. The RL2755HM has two HDMI ports for hooking up multiple consoles, along with DVI and VGA connectors for a desktop PC or laptop. This should be plenty for most users, although the three (or more) button presses required to switch input sources is a little long-winded. There are no USB ports either, so you'll have to run cables

from your consoles to recharge any wireless controllers.

Perhaps the biggest crime of all is the speakers. Yes, there are 3.5mm audio outputs for headphone users, but you won't want to have your ears smothered by your headset all the time, and a pair of decent speakers would have been very welcome. Instead, you get two 2W tweeters that produce absolutely no bass. For a device that should be able to replace a TV, this feels like a missed opportunity and means you'll need to spend more money on a set of external speakers.

The TN panel offers up bright images: at its default settings we measured its brightness

as 321cd/m², although you'll want to turn this down if you'll be using the screen for long periods and sitting up close. Image quality falls apart elsewhere, however, with colour coverage coming in at just 91.1% using the most accurate sRGB preset. Contrast levels are fine at 1,156:1, although black levels were a little high at 0.27cd/m².

The backlight is reasonably uniform up to the very edges of the monitor, where it falls away dramatically. We saw dark patches along the right edge and hints of this on the bottom too. This is evidence of the fact that the RL2755HM uses a cheap TN panel, as are the narrow viewing angles. You see tinges of yellow if you begin to view this monitor from anything other than straight on.

The main justification for using a TN panel over a better quality panel (aside from price)

is a quicker response time.

This means there's less delay in your control inputs appearing onscreen, so you can react faster and gain a competitive advantage. Some TVs have input lag of more than 30ms, which is noticeable when playing games. Using our Leo Bodnar input lag tester, we measured the RL2755HM's lag as 10ms, which is very good. We're not convinced that this is a major benefit when playing console games at 30fps, so it's debatable whether the numerous image quality compromises were worth making for the better performance.

It's really only through software customisation that BenQ makes a case for the RL2755HM as a gaming monitor. It has lots of extra image settings to bump up contrast, dim the outer edges of the screen to focus your eyes on the centre and remove distractions. You can even change the size of the output if you want everything to appear smaller.

The BenQ RL2755HM isn't particularly expensive for a 27in monitor, but we're not convinced by its console gaming focus. Unless you truly believe a slightly quicker response time will net you better results when gaming, we'd stick with a smaller bedroom TV or buy a monitor with better image quality, such as one of the many similarly priced 27in VA, IPS or PLS monitors on the market.

Michael Passingham



SPECIFICATIONS

SCREEN SIZE 27in • RESOLUTION 1,920x1,080 • SCREEN TECHNOLOGY TN • REFRESH RATE 60Hz • VIDEO INPUTS 2x HDMI, DVI, VGA • WARRANTY Two years onsite • DETAILS benq.co.uk • PART CODE 9H.LD8LB.QBE

CONNECTION PORTS





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VERDICT

Comprehensive Smart TV features make this a superb, if expensive, Ultra HD TV

LG MAY BE turning its attention to OLED technology and curved screens, but that doesn't mean it is neglecting LCD sets. The 60UF850V is LG's latest: a 60in, 4K model that looks great before you even switch it on.

With almost no bezel around the top and sides, brushed metal trim at the bottom and a curved metal stand, the TV is undeniably sleek. However, the stand's shape, with a flat bar at the front and legs that point out at the back, gives it a rather large footprint.

The brushed metal extends to the remote control, too. The revised Magic Remote places all the important buttons at your fingertips, as well as motion-based cursor controls for navigating the colourful WebOS interface.

LG has given its card-based Smart TV UI a minor overhaul, but the most important tweaks are behind the scenes. Everything is faster than on last year's model, so you don't have the same irritating wait of up to a minute before you can change inputs or open services. Even better, you can jump out of online streaming to catch something on live TV, then return to where you left off without having to reload the entire app.

STREAM ENGINE

WebOS is overflowing with content, making it the obvious choice for fans of TV on demand. Samsung's Tizen TVs might have All 4 (formerly 4oD) and ITV Player, but LG has exclusive access to Sky's Now TV. This is on top of BBC iPlayer and Demand 5 catch-up TV, as well as Netflix and Amazon Instant Video, which stream in 4K as long as you have a 25Mbit/s or faster internet connection.

There are plenty of ways to watch your own content, too, with DLNA support to stream audio and video from a server or render content sent to the set, and Intel WiDi screen streaming from a compatible device. All three worked flawlessly in our tests. One of the HDMI inputs supports MHL for connecting a smartphone or tablet, and one of the three USB ports uses the faster USB3 standard to help with uninterrupted playback of 4K video. The single HDMI 2.0 port will support super-smooth 4K 60p sources as soon as they arrive.

As with the rest of LG's 4K TV line-up, if you can feed the 60UF850V a 4K video source the



level of detail on display is stunning. We were able to make out the logos on the tiny bank of microphones in front of Kevin Spacey during a press conference in *House of Cards* on Netflix, and *Better Call Saul* looks even grittier than it does in Full HD.

1080p content is a lot easier to come by, and thankfully the 60UF850V does a great job of upscaling to 3,480x2,160, with few visible artefacts. Standard-definition content was another story – low-bitrate Freeview channels such as Dave looked fuzzy and pixelated.

We used our colour calibrator to measure the TV's image quality. At its default settings the 60UF850V wasn't overly impressive: the IPS panel displayed just 92.8% of the sRGB colour gamut in the Standard picture mode. That's a little low for a top-end TV, so you'll have to make quite a few tweaks to get as close to a perfect picture as possible.

Brightness levels were much higher than average at 355.5cd/m², although black levels take a hit as a result, with our calibrator measuring 0.4cd/m². Most high-end TVs have black levels of around 0.2cd/m², so this was a little disappointing, but given the high brightness levels there's plenty of room for adjustment.

Digging into the settings menu, we changed the picture mode to Cinema, lowered the backlight, tweaked brightness and contrast and switched the colour temperature to Neutral. We also switched off dynamic contrast and dynamic colour in the Advanced menu. Here you can also adjust the aggressiveness of LG's Super Resolution upscaling, so you can dial it down to reduce display lag when playing fast-paced games.

Finally, the Expert Control menu is only available in Cinema and ISF picture modes, but it gives you access to comprehensive (20-point) white balance options

and a full colour management system for fine-tuning. Changes here can make a big impact to picture quality, but the settings are far from user friendly. If you don't know what you're doing, it's best to stick with the basic colour slider in the Picture menu.

SCALE MODEL

After our changes, Blu-ray films looked vibrant and full of detail. We measured a respectable 876:1 contrast ratio, which was reflected in the clarity of dark scenes in *Star Trek: Into Darkness*. Camera pans were free from judder with LG's TruMotion frame interpolation set to add extra frames.

In Game mode, our Leo Bodnar lag tester measured a reasonably low 48ms. While this isn't the fastest TV we've seen, console gamers won't see a noticeable input delay.

The 60UF850V offers all the connectivity, content and features you'd expect from a flagship TV. You pay a premium for 4K, but the incredibly sharp picture and delightfully simple WebOS interface make this TV as much a joy to use as to watch. Default image quality may not be class-leading, but it only takes a few tweaks to get an excellent picture. If you want a TV that can become the focal point of your living room, the 60UF850V is a brilliant choice, but Panasonic's Viera TX-55AX902B is a worthy alternative if you particularly value deep blacks and accurate colours.

Tom Morgan



SPECIFICATIONS

SCREEN SIZE 60in • **NATIVE RESOLUTION** 3,840x2,160 •
VIDEO INPUTS 2x HDMI 2.0, 1x HDMI 1.4, SCART, Composite,
Component • **TUNER** Freeview HD • **WARRANTY** Five years
RTB • **DETAILS** www.lg.com/uk • **PART CODE** 60UF850V

CONNECTION PORTS



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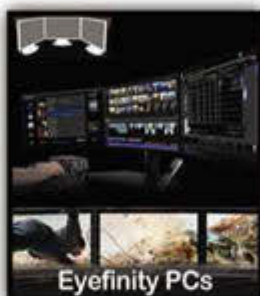
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CRYSTAL ACOUSTICS

Teevy 6



£299 inc VAT • From www.crystallaudio.com

VERDICT

It looks basic, but clever internals make the Teevy 6 sound great



SOUNDBARS, SOUND BASES and any other speaker systems where the drivers all point in one direction typically suffer from the same problem: the audio they produce sounds right only from a single point, or 'sweet spot'. Crystal Acoustics claims its WiSound range of audio gear, of which the Teevy 6 is a part, directs sound around a room more effectively, with no need for multiple speakers.

The Teevy 6 sound base is the first device we've seen with this technology. It's not the most attractive speaker to place your TV on, as it's chunky, black and made almost entirely from MDF. It's designed for 55in TVs, but as long as your set is no heavier than 60kg and requires no more than 720x280mm of standing room, the Teevy 6 should support it. The finish feels tough enough to resist scratches when placing your TV on top, and the silver WiSound logo and feet try to add a little class, although the black cloth covering the speaker drivers looks fairly drab.

The remote feels disappointingly cheap too, with only power, volume and input selection controls. It's tiny, with a horrible black plastic finish that shows off fingerprints almost instantly, and it takes a watch battery, which wasn't even included with our review sample. There's no screen on the main unit – instead a single LED changes colour to indicate which input is selected and blinks when you issue a command. That's all you really need, though, as there are no tone controls. The main unit has no buttons on it at all, so if you lose the remote you won't even be able to turn it on.

The Teevy 6 is unashamedly simple, with only digital optical, 3.5mm audio and stereo RCA inputs on the back. There's also a USB port, but it's for charging up a mobile device. You can't use it as an audio input. With no

HDMI input, you'll have to send audio from a Blu-ray player or games console through your TV. You also get Bluetooth, but there's no NFC for easy pairing of a smartphone.

The speaker is fairly large, but it provides room for six balanced drivers inside. Two mid-range drivers face forwards, a mid-range driver fires outwards on both sides and the woofer drivers fire down. These are combined with a digital signal processor (DSP) that has been designed specifically to use reflections from walls, which Crystal Acoustics hopes will make your films, games and music sound better than with other soundbars or bases.

music as you're not guaranteed to be sitting in a particular position. Even so, we were able to walk around the room without noticing any obvious gaps in audio coverage or any change in the mid-range or treble response when we changed position.

We weren't left wanting for volume either. Although the Teevy 6 won't fill a cavernous living room completely, even at maximum volume, we could watch TV comfortably from several feet away with the volume set to less than half the maximum. Turned up to full, the

We were able to walk around the room without noticing any obvious gaps in audio coverage or any change in the mid-range or treble response when we changed position

When we tested the Teevy 6 we placed it close to the wall, which is typical of most living room setups. Because the speaker drivers are positioned in opposite pairs, and the DSP is designed to take both direct and reflected sound into account, it should be able to cope well with most listening positions and placements regardless of the shape of your room or the position of your furniture.

Although we'd agree that the WiSound technology makes a difference compared with more traditional soundbars and bases, the lack of any up-firing speakers means the Teevy 6 can't create a completely convincing surround-sound effect. There's no sense of height, which might be fine for watching TV or films but is less helpful when listening to

drivers took on a slightly harsh edge, but there's still enough leeway if you like it loud.

Sound quality was impressive, too, with impeccably clear vocals for films and TV no matter where we sat in a room. There was more than enough bass for everyday viewing too, although we'd have liked some tone controls to give explosions and action sequences a little more oomph. This balance extended to audio, where high-end cymbals and hi-hats sounded crisp without being overpowered by the mid-range or bass.

With limited inputs, a basic design and practically no controls other than volume, the Teevy 6 is an undeniably simple sound base from the outside, but some clever DSP and speaker placement makes it more than suitable for TV, films and occasional music playback. Panasonic's SC-HTE180 has a convenient HDMI input, costs less and is arguably more attractive, but it can't match the Teevy 6 for sound quality.

Tom Morgan



↑ Downward-firing drivers create ample bass, while the others handle the mid-range and high end

SPECIFICATIONS

SPEAKERS 7 • **RMS POWER OUTPUT** 100W • **DIMENSIONS** 75x900x120mm • **WEIGHT** Not stated • **DOCK CONNECTOR** None • **NETWORKING** Bluetooth (SBC, apt-X) • **WARRANTY** One year RTB • **DETAILS** www.crystallaudio.com • **PART CODE** BTS-6-BUK

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VOICE-ORIENTATED SOUNDBAR

POLK MagniFi



£400 inc VAT • From www.richersounds.com

VERDICT

Gives speech a real boost in films and TV, but the Polk MagniFi isn't designed for music

TV SPEAKERS ARE typically hampered by the fact that they have to be tiny to fit behind ever-thinner panels, but they also suffer because they don't point directly towards the viewer. Down-firing and rear-firing TVs bounce sound off walls, but this can make it tricky to hear certain aspects of a sound mix. Polk's MagniFi soundbar not only points the speaker drivers directly at you, but has been configured to improve speech comprehension in films and TV programmes.

At 960mm the MagniFi is the perfect size for a 47 to 50in TV, although whether or not it fits under one will depend on the shape of the stand. If you have a bigger TV, the soundbar may look a little out of place. The combination of grey and silver plastics isn't exactly offensive, but we expected a little more from the construction given the price.

The MagniFi is surprisingly simple for a £400 soundbar, as it has only a digital optical input port and a 3.5mm auxiliary input on the back. The lack of HDMI means you're out of luck if your TV doesn't have optical S/PDIF, and there's no onscreen interface for adjusting the sound characteristics either.

A row of LEDs on the front of the unit indicate the active input. These change colour when you adjust the volume and flash with different patterns when changing the sound mode, but are dim enough that they won't be distracting if you're watching TV in the dark.

You can switch input, change volume and adjust bass or voice levels using either the buttons on the top of the unit or the supplied remote control. The remote is a cheap, slim model that's easy to lose down the side of the sofa. The soundbar has a learning function, so you can replace the remote if you like, but it only works with infrared remotes – our RF remote wasn't recognised at all.

Polk has designed the MagniFi with films and TV in mind. The centre speaker has been



given priority to ensure speech is always clear and easy to hear, while the mid-range makes up a dominant part of the overall mix. It worked well when watching broadcast TV, although the sound stage felt a little enclosed for films. Thankfully dialling down the Voice level restored some balance and gave the impression of a wider sound.

This focus on speech does mean that music playback suffers as a result. There's a distinct lack of treble, and the high-end is muddled by the mid-range in most energetic songs. Adjusting the Voice level can't fix this either, as it merely redistributes the mix with greater focus on the centre channel rather than tweaking its sound characteristics.

This is a shame, as the MagniFi has NFC for quickly pairing a smartphone and supports

you plug it in. Oddly, there's a 3.5mm audio jack on the back for connecting the two with a cable, but the supplied cable is only a metre long so we can't see why you'd use it instead of a wireless connection. The soundbar-to-sub connection worked perfectly from across the room during our testing.

The subwoofer itself is big and boxy, which could make it difficult to hide behind a sofa. However, it produces deep bass for films, games and heavier music tracks. You can't adjust subwoofer strength independently from the soundbar, but it's more than loud enough to make itself heard.

The MagniFi soundbar is impressively loud for its size. We were able to listen comfortably from five metres away at only a third of maximum volume

the less-lossy aptX Bluetooth playback from compatible handsets. Polk's DJ Stream app takes this a step further, allowing four connected devices to build up a playlist and stream through the soundbar. We weren't too fond of the kitsch wood panels within the app, but it worked well, allowing us to create a playlist with music from three different smartphones at once.

The accompanying wireless subwoofer pairs automatically with the soundbar when

In fact, the entire package is impressively loud for its size. We were able to listen comfortably from five metres away at only a third of maximum volume, and turning it up to 50% gave films and games real presence. Things did sound a little boomy at maximum volume, but there was no distortion.

The MagniFi is an interesting idea. It clearly works as intended for films and TV, with a focus on speech and a dominant mid-range, but is less effective when listening to music. If we'd spent £400 on a sound system, we'd expect it to work well with all kinds of audio. Unless you already have separate speakers specifically for music, the Samsung HW-H750 is a better buy overall.

Tom Morgan



SPECIFICATIONS

SPEAKERS 3 • **RMS POWER OUTPUT** 300W • **DIMENSIONS** 965x52x76mm • **WEIGHT** 2.2kg • **DOCK CONNECTOR** None • **NETWORKING** Bluetooth (SBC, apt-X) • **WARRANTY** One year RTB • **DETAILS** www.polkaudio.com • **PART CODE** SKU 1237

PORTABLE DAC/HEADPHONE AMPLIFIER

CREATIVE Sound Blaster E5



£164 inc VAT • From www.amazon.co.uk

VERDICT

This headphone amp, USB sound card and DAC performs well but is bulky

CREATIVE HAS PACKED a lot into the Sound Blaster E5, a headphone amp, USB sound card and DAC that's no bigger than a portable hard disk. It has all the outputs you could need, with dual headphone jacks and an optical out port that doubles as a 3.5mm line out.

The headphone amp supports headphones with sensitivities as low as 2.2ohms and up to 600ohms using a high gain switch on the side. We had no trouble driving our Sennheiser HD700 over-ears set, but it's a shame there's no 6.3mm headphone jack for truly high-end headphones. A 6.3mm to 3.5mm adaptor costs only a few pounds though.

As well as the optical in/3.5mm line in combination jack, a full-size USB host port lets you connect the E5 to an iOS or Android

device. The E5 will perform far better than the DACs in most smartphones or tablets, but given how bulky it is, we wouldn't want to put it in the same pocket as our phone. Two tough elastic bands are included to keep your phone safe, so they won't fly apart in a bag at least.

A Micro USB port lets you connect the E5 to a PC or Mac and use it as an external sound card. An angled desktop stand is also included for this. The E5 charges over Micro USB, and its battery is rated for eight hours when listening via Bluetooth. We found this to be a realistic figure. The E5 also acts as a portable battery when connected to a smartphone, but sadly you can't disable this to stop your phone draining the E5.

As well as the multitude of ports, the E5 supports Bluetooth 4.1 Low Energy connectivity and the less-lossy aptX codec, which in effect turns any pair of wired speakers or headphones into a wireless set.

The E5 uses a Cirrus Logic CS 4398 DAC, which can process 24-bit/192kHz audio over

USB. This drops to 24-bit/48kHz when connected to an iOS device, and 16-bit/44.1kHz on Android through the USB host port. Apps are available for both mobile operating systems, as well as SBX Pro Studio desktop software for PCs and Macs.

Beyond customising EQ and enabling virtual surround, which we found worked well for films, you can use SBX Dialog Plus to add clarity to dialogue. We were also impressed by CrystalVoice, which reduces background noise and echoes when using a microphone.

You can connect an external mic to the E5's line in port, but the built-in mics are surprisingly sensitive, making this a viable device for making hands-free calls.

The E5 is undeniably versatile but it's a bit too bulky to be truly portable. It isn't quite as well-specified as the stationary Sound Blaster X7, either, but it's considerably cheaper, so it could still be a good choice if you want a DAC that you can occasionally take on the move.

Richard Easton



SPECIFICATIONS

WARRANTY One year RTB • **DETAILS** uk.creative.com • **PART CODE** Sound Blaster E5

BLUETOOTH SPEAKER

ULTIMATE EARS UE Megaboom



£236 inc VAT • From www.ballicom.co.uk

VERDICT

A bassy, powerful Bluetooth speaker, but the UE Megaboom has a few design quirks

WHEN IT COMES to describing the volume and sound signature of Ultimate Ears' latest Bluetooth speaker, the clue is in the name. If your music collection largely consists of heavy tracks with plenty of bass, the UE Megaboom should definitely pique your interest.

It sounds warm and impactful, and is particularly loud near its maximum volume, making it perfect for an outdoor party but not necessarily for those who want a more critical, flat sound. The cylindrical design also helps it project sound in almost every direction, avoiding the directionality inherent to some portable Bluetooth speakers.

We like the look of our black review sample, but the Megaboom is also available in red, blue and plum shades. Whatever your colour choice, every speaker is IPX7 water-resistant to 1m for up to 30 minutes, so it's great not only for outdoor use by a pool but for more mundane tasks such as a shower speaker. There are no exposed metallic screws

to rust as we've seen with other supposedly water resistant speakers. You simply need to ensure the waterproof flaps on the base are firmly closed.

The two large volume buttons along the edge are almost impossible to miss, and the NFC contact point below it is great for pairing compatible smartphones. There's a much smaller Bluetooth pairing button for connecting iPhones and other handsets that lack NFC. The Megaboom has excellent Bluetooth range – we were able to get more than 20m away from the speaker before music became interrupted. It's just a shame there's no Bluetooth aptX support.

If you have two Megaboom speakers, you can pair them as a stereo system using the UE Megaboom app for iOS and Android. Compatible devices can also switch on the speaker remotely using Bluetooth Smart. It's a



simple feature but an incredibly convenient one.

Battery life is excellent, thanks in part to a large 3,600mAh battery. It managed more than 15 hours of playback at medium volume before needing a charge, putting the Megaboom up there with the Bowers & Wilkins T7 for longevity.

There's not much to dislike about the UE Megaboom provided you're happy with a very warm, bassy sound and don't mind its large size. We still prefer the smaller and slightly cheaper Best Buy-winning Fugoo coupled with its Sport jacket, especially for outdoor use thanks to its rugged design, but the UE Megaboom is still a great choice.

Richard Easton

SPECIFICATIONS

SPEAKERS 4 • **RMS POWER OUTPUT** Not disclosed • **DOCK CONNECTOR** None • **WIRELESS** Bluetooth (SBC) • **DIMENSIONS** 83x83x226mm • **WEIGHT** 877g • **WARRANTY** Two years RTB • **DETAILS** www.ultimateears.com • **PART CODE** 984-000438

MEDIA-STREAMING STICK

AMAZON Fire TV Stick

COMPUTER
SHOPPER
RECOMMENDED



£35 inc VAT • From www.amazon.co.uk

VERDICT

The Amazon Fire TV stick is a bargain-price streamer that excels if you're an Amazon Prime subscriber

GOOGLE KICKED OFF a media streaming revolution with its Chromecast, which launched at a very reasonable price and transformed the way we share content from our phones to the big screen. It was swiftly followed by the similar Roku Streaming Stick, and now Amazon has thrown its hat into the ring with its own a media streaming stick.

Much like the Chromecast, the Fire TV Stick is no larger than a typical USB flash drive. An HDMI connection on one end plugs into your TV, and a Micro USB port on the other provides power. Unlike the Chromecast, however, the Fire TV Stick draws too much power to run off your television's USB ports, so a wall adaptor is included. Basic features such as on-demand streaming might work when connected to your TV's USB ports, but games may refuse to play without a dedicated power supply. An HDMI extension cable is also included, which could be useful if your TV's HDMI ports are very close together.

The Fire TV set-top box has an optical S/PDIF audio output for soundbars and surround-sound systems, but this is missing from the much smaller Fire TV Stick. It's still capable of up to 7.1 channel audio, however, and outputs a 1080p image.

The dedicated remote control provides all the media and navigation controls you'd expect but lacks the voice recognition feature that made navigating and searching for content on the Fire TV set-top box so easy. A Fire TV Remote app for iOS and Android restores this feature and also duplicates the remote's inputs. Swipe and tap motions on an onscreen touchpad worked well, and a touchscreen keyboard is much better than the remote control for entering text.

PRIME MOVER

The Fire TV Stick's interface is largely the same as that of the Fire TV. A vertical list branches into a horizontal carousel of tiles based on different categories, such as Movies and Music. Not surprisingly, Amazon's Instant Video service is given a prominent location. Instant Video is a major part of Amazon's Prime service, which costs £79 per year and includes free next-day delivery for Amazon purchases, among other perks. It's also available on its own for £5.99 a month.

Amazon has done a great job of bolstering its content catalogue over the past year, with some exclusive shows that aren't available to stream elsewhere. It also offers extra premium content to rent for an additional fee.

The Fire TV Stick uses Amazon's Advanced Streaming and Prediction (ASAP) technology, which is supposed to predict what you're likely to watch and buffer it in the background. It worked reasonably well during our testing, beginning the next episodes of shows we'd been watching almost instantly rather than after a few short seconds. Even when it hadn't buffered, we never had to wait long to play Amazon Instant Video content.

ASAP tends to kick in less often when you flit between different films or shows than when watching consecutive episodes of the same TV series. It does at least buffer content if you spend a few seconds reading a programme or movie description, though, which is handy for anyone who can't decide what to watch.

COOL STREAM

Access to Amazon's App Store enables you to add extra on-demand and catch-up services to the Fire TV Stick's home screen. Many of the big-name apps are available, including Spotify Connect for music streaming, YouTube for watching web videos, Sky News and BBC Sport. You can also download games and play them using your remote or an optional Fire TV games controller (£35 from Amazon). The Fire TV Stick isn't quite as powerful as the Fire TV set-top box, but you can still get away with playing the basic games you'd usually find on your smartphone.

There's also a Netflix app for subscribers, which means the Fire TV Stick can be a single hub for access to two huge streaming catalogues. Apps can be a little slow to load, however, with YouTube taking a few seconds.

For catch-up television the Fire TV Stick falls a little short. There's BBC iPlayer and Demand 5, but ITV Player and All 4 (previously 4oD) are absent, so you have only half the roster of terrestrial UK channels. You can always use the AllCast app to stream these missing services from a smartphone, but given that the app store is a major reason to buy a Fire TV Stick over a Chromecast, it's irritating to have to do this.

If you have a Kindle Fire tablet or smartphone, you can mirror your screen

without installing any third-party apps, as they can communicate natively. Screen mirroring certainly isn't as seamless or straightforward as on a Chromecast, however. The Fire TV Stick supports the Discovery and Launch (DIAL) protocol with certain apps, such as YouTube, which allows it to act much like a Chromecast, but this is on a per-app basis. You will also need to install the corresponding app on the Fire TV, which isn't a requirement with the Chromecast.

Finally, you can play your own content using apps such as Plex and even access Plex Cloud Sync servers through the dedicated Plex for Fire TV app, which isn't always available through every version of Plex. In theory, DLNA servers and AirPlay streaming are supported using third-party apps such as AirPlay/DLNA Receiver, although we had difficulty streaming Full HD content from an iPhone over a wireless network, which resulted in broken and distorted video.

LAUNCH PAD

The Amazon Fire TV Stick is great value at £35. It doesn't quite offer all the features of a Chromecast, but it comes very close thanks to its support for the DIAL protocol. Even if you're not an Amazon Instant Video subscriber, the low cost of the Fire TV Stick makes it an enticing prospect for streaming local content through apps such as Plex.

The interface is quick and responsive, save for the occasional slow app load, and the remote control adds a degree of convenience over the Chromecast. You still have the option of using a smartphone or tablet as a remote too. The Fire TV Stick is also cheaper than the Roku Streaming Stick, making it our new favourite discrete streaming device.

Richard Easton



SPECIFICATIONS

VIDEO OUTPUTS HDMI 1.4 • **NETWORKING** 802.11n • **DIMENSIONS** 115x115x17mm • **STREAMING FORMATS** UPnP, AirPlay, DLNA • **INTERNET STREAMING SERVICES** iPlayer, Netflix, Sky News, Spotify, TuneIn Radio, Amazon Instant Video, TVPlayer • **WARRANTY** One year RTB • **DETAILS** www.amazon.co.uk • **PART CODE** Fire TV Stick

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ACTION CAMERA

ROLLEI Actioncam 400



€130 (around £94) inc VAT • From www.rollei.com

VERDICT

The Rollei Actioncam 400 is a fully featured budget action camera, but its image quality disappoints

IT MAY BE boxier than some of Rollei's other action cameras, but the Actioncam 400's keen price makes it a tempting prospect – especially as it includes a comprehensive array of accessories as well as a camera that shoots 1080p video at 30fps. Despite the entry-level price, the 78g camera is light enough to be unobtrusive when mounted to a helmet.

The rubbery exterior provides plenty of grip, making it ideal for handheld use if you take it out of its waterproof case. The case enables you to submerge the camera to depths of 40m. Plenty of other accessories are included, such as a bike mount, a helmet mounting plate, a pair of helmet straps and a pair of adhesive pads. Sadly, the quality of the pads left a lot to be desired – when we used them to attach the camera to our remote control car for testing, they struggled to keep the Actioncam secure, even at low speeds.

Framing shots is easy with the 2in LCD screen, which shows a live view of the camera's sensor. The 960x240 resolution is perfectly adequate for a screen of this size and it's bright enough to use outdoors, although images look rather grainy.

Power and record buttons are placed conveniently on the top of the camera, and the dedicated Wi-Fi button is a welcome addition. The physical buttons are useful for navigating the menus when changing settings, but using the Rollei companion app for iOS and Android is much less fiddly. Your phone or tablet connects to the camera over Wi-Fi, which you can toggle on and off quickly using the dedicated button. Once paired, the app is

quick to acknowledge the camera and you can change all the settings you'd expect.

Live view is available through the app, but in use we experienced a disorientating two-second delay between what the camera sees and what is shown onscreen. The image is also heavily compressed, with lots of artefacts on the live feed. This is disappointing when other action cameras are able to provide a much clearer view over Wi-Fi.

BUCKLE UP

Smartphone controls aren't always practical, especially if you're wearing gloves or you need both your hands free, so the inclusion of a wrist-worn remote control is great. This has three large buttons with LEDs that let you know when the camera is recording. It maintained a connection up to 15m, which is respectable, and recharges over Micro USB, like the Actioncam itself. With a rated battery life of around 240 hours, it shouldn't run out of juice in a hurry. We didn't have to recharge the remote once during our tests, but the camera itself was a little disappointing, lasting just an hour and 15 minutes when recording in 1080p at 30fps.

The Actioncam's only other recording resolution is a 720p/60fps mode. There are no options for faster frame rates, even by sacrificing the resolution, which is typical on other action cameras. This is bad news for



anyone who wants to create slow-motion videos, as footage from this camera will be jerky when played at anything other than full speed. The 3-megapixel sensor can of course be used to snap still images as well as shoot video, and there's a time-lapse setting for taking a sequence of photos at intervals of between five and 60 seconds.

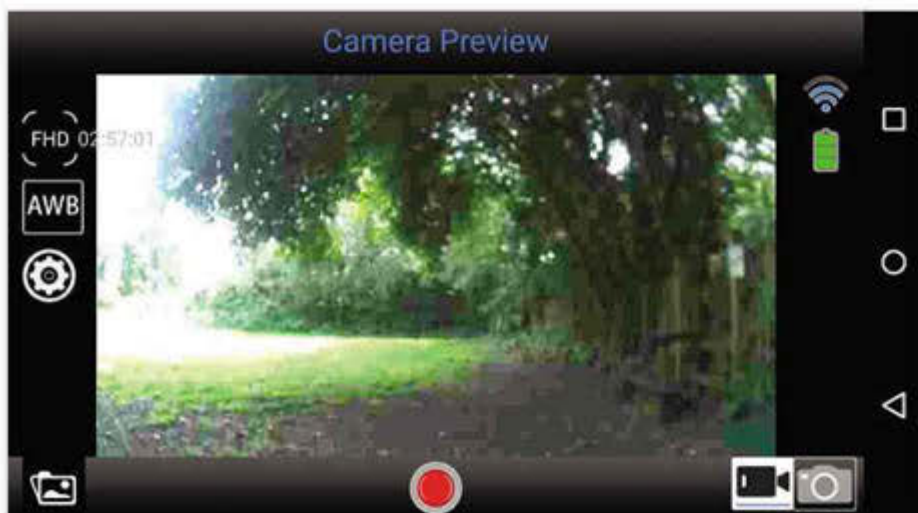
Sadly, image quality isn't particularly impressive either, especially when shooting through the waterproof case. The lens struggled to focus through the case, leaving our test videos looking too soft, both with the Actioncam attached to our RC car and when set up in a stationary position.

SOFT FOCUS

Shooting without the case improved image quality, but our test footage still lacked sharpness. The corners of images were soft, and colours were a little too subdued for our liking. Video was also less stable than we would have liked, with wobble and shearing evident in our RC car test footage. There was little in the way of barrel distortion, though, which is surprising for an action camera.

Despite the wealth of accessories and the genuinely useful wrist-worn remote control, the Actioncam 400 doesn't do enough to excite us, even at such a low price. Its image quality is disappointing, as are the insecure mounting pads. If you're looking for an entry-level action camera, you're better off buying the £150 Drift Stealth 2, which has far superior battery life and image quality – even if you have to buy the accessories separately.

Richard Easton



↑ The companion app is a great way to change settings but the live view image quality is disappointing

SPECIFICATIONS

SENSOR 1/3in CMOS • **SENSOR PIXELS** 3,000,000 • **MAX RECORDING RESOLUTION** 1080p (30fps) • **AV CONNECTIONS** Micro HDMI • **SIZE** 54x37x51mm • **WEIGHT** 78g • **WARRANTY** One year RTB • **DETAILS** www.rollei.com • **PART CODE** Actioncam 400

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SMALL INKJET MFP

EPSON Expression Home XP-422



£55 inc VAT • From www.amazon.co.uk

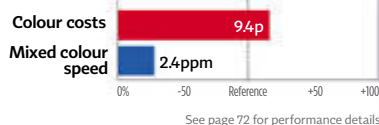
VERDICT

Comparatively slow and basic, but print results are good for the money

EPSON CALLS THE Expression Home XP-422 a 'small in one', which made us wince, but to be fair it's a very compact inkjet multifunction peripheral (MFP). It's fairly attractive, with an angled control panel featuring a colour screen and touch-sensitive keys. It has Wi-Fi and an SD memory card slot but no automatic duplex (double-sided) printing. Paper is fed from an uncovered 100-sheet tray at the rear, and

SPECIFICATIONS

TECHNOLOGY Piezo inkjet • **MAXIMUM PRINT RESOLUTION** 5,760x1,440dpi • **MAXIMUM OPTICAL SCAN RESOLUTION** 1,200x2,400dpi • **SIZE** 145x390x300mm • **WEIGHT** 4.3kg • **MAXIMUM PAPER SIZE** A4/legal • **WARRANTY** One year RTB • **DETAILS** www.epson.co.uk • **PART CODE** C11CD89401



printed pages end up in a simple but sturdy tray at the front.

The XP-422 is more sophisticated than an entry-level device but misses out some of the features of mid-range MFPs. NFC support isn't a major omission but there are no downloadable modes or functions either, which is a shame as they can be useful. Cloud services such as Evernote and Dropbox are supported, but you can't configure them directly from the printer as you can on some rivals. Oddly, you can't print documents or photos stored on the same cloud services, and while you can scan to an SD card or print photos stored on one, you can't make direct prints of other document types such as PDFs.

This isn't the fastest MFP, even over a USB connection, but at least it's quiet. It printed normal quality text at a sedate 8.9ppm, although this almost doubled to 16.9ppm at draft quality. Colour printing was far slower, with our graphics-rich test page inching out at 2.4ppm and 6x4in photos taking almost three

minutes. Scanning was more competitive except at high resolution: a 1,200dpi scan of a 6x4in photo took over two minutes.

Fortunately, the results looked good. Text was dark and sharp, and colour graphics were crisp, with bold, bright colours. Scan quality was great, aside from a slightly soft focus, and photocopies had well-judged exposure and colour accuracy. Photos also had accurate colours and were reasonably sharp, although there was some subtle grain in lighter regions.

This printer takes four consumables, with an XL version of each available. While these help reduce the amount of ink changing you'll do, they don't keep print costs especially low: each page of text and graphics will cost around 94p, of which the black component amounts to 2.8p. While this is a good MFP for the money, we'd pay £15 or so more for Canon's Pixma MG5650, which is faster, produces comparable results or better, has duplex and is cheaper to run.

Simon Handby



HOME OFFICE INKJET MFP

HP Officejet 5740



£79 inc VAT • From www.hp.co.uk

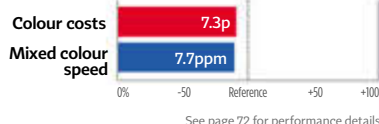
VERDICT

Looks alone don't make a good small office MFP

HP'S OFFICEJET 5740 is essentially a version of the great-looking Envy 5640 with a fax modem and a compact, 25-sheet automatic document feeder (ADF) added. It's not quite as sleek as the Envy 5640 but has similar colour touchscreen controls and the same excellent build quality. The scanner tilts up on heavily damped hinges to grant access to the

SPECIFICATIONS

TECHNOLOGY Thermal inkjet • **MAXIMUM PRINT RESOLUTION** 4,800x1,200dpi • **MAXIMUM OPTICAL SCAN RESOLUTION** 1,200x1,200dpi • **SIZE** 193x452x410mm • **WEIGHT** 7.7kg • **MAXIMUM PAPER SIZE** A4/legal • **WARRANTY** One year RTB • **DETAILS** www.hp.com • **PART CODE** B9S79A



ink cartridges, while the USB and SD card slots are hidden behind a neat rotating door.

The colour display is perfectly responsive, and you can use a mix of tap, drag and swipe gestures in the intuitive menu system to control web features as well as core functions. The feature set isn't exhaustive, however, as you can't scan to or print from cloud storage.

The Officejet 5740 isn't especially fast at printing text, as it delivered our test letter at 11ppm. Colour print performance was more competitive, with our complex graphics document arriving at a healthy 7.7ppm. The scanner wasn't quick either, needing 23 seconds to capture an A4 page at 300dpi. The glacial ADF slowed things down further – a 10-page photocopy took two minutes and 22 seconds in black, while in colour the job required a further two minutes.

The quality of prints and photocopies on plain paper is hard to fault, and its photos aren't bad either. Scans are fine at low

resolutions too but had an overly processed and artificial appearance at 600dpi. This problem is compounded by HP's over-simplified scan software, which lacks auto-exposure, among other things.

After the Envy 5640, the Officejet 5740 was only the second printer ever to run out of ink during our standard tests. It's a good job the device is compatible with HP's Instant Ink, where the printer orders more cartridges as needed. While it ships with cartridges rated for 200 black and 165 colour pages, the former expired with little warning after 50 pages of text, 34 mixed pages of text and graphics, 22 black and colour photocopies and two A4 photos. Extra large replacements have three times the capacity and lead to running costs of around 7.3p per page. That's reasonable, but it's not low enough to offset patchy performance elsewhere. We'd spend more for Epson's Workforce WF-3520DWF.

Simon Handby



A3 INKJET MFP

BROTHER DCP-J4120DW



£79 inc VAT • From www.ebuyer.com

VERDICT

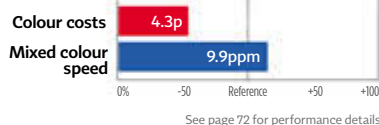
A compact and affordable way to print on A3 paper, but doing so is a faff

THE DCP-J4120DW IS an A4 inkjet MFP that offers A3 printing, which could make it ideal for those without room for a full A3 printer. It's quite attractive and not much bigger than a typical office inkjet MFP, but the price is keen given that it includes Wi-Fi, a colour touchscreen, front USB and memory card slots and duplex (double-sided) A4 printing.

The reality, however, is somewhat

SPECIFICATIONS

TECHNOLOGY Piezo inkjet • **MAXIMUM PRINT RESOLUTION** 6,000x1,200dpi • **MAXIMUM OPTICAL SCAN RESOLUTION (OUTPUT BIT DEPTH)** 2,400x1,200dpi (24-bit) • **SIZE** 163x480x290mm • **WEIGHT** 8.1kg • **MAXIMUM PAPER SIZE** A3 • **WARRANTY** One year RTB • **DETAILS** www.brother.co.uk • **PART CODE** DCPJ4120DWZU1



disappointing. To accommodate the width of A3 sheets, the DCP-J4120DW unusually loads A4 paper sideways in the 150-sheet paper cassette. This isn't a problem, but A5 or 6x4in media loads with a portrait orientation, which could be confusing. A3 doesn't fit in the tray; instead loads through a feed at the back, which accepts only single sheets.

Printing A3 involves offering a sheet to the slot, supporting the page while it prints and tapping a button when you're ready to collect it from the output – pages aren't ejected without this as the output tray is too short to hold them. On a multi-page job it's a real faff.

It's a fast printer, managing 15.2ppm for text at the normal setting, rising to 19ppm at draft quality, while colour graphics printed at 9.9ppm. An A3 page of text took 34 seconds, while an A3 page of colour graphics took 38 seconds. Print quality isn't great: text was tidy and quite sharp but less black than from the best inkjets. The story was similar for graphics, which looked somewhat washed out.



Scanned images looked sharp, but colours were a touch undersaturated, and not all the detail was preserved from among the darkest shades. Scans were reasonably fast, at least, with the scanner taking just 13 seconds to capture a page at 150dpi. You can only scan documents up to A4 size though.

The touchscreen menu is generally good, and we like its shortcut page for adding links to your favourite features. The screen isn't perfectly responsive, however, and we found operations such as entering text tricky. It's also odd that you can scan to an inserted memory device but can only print photos from one – not documents such as PDFs.

This MFP isn't perfect but it is cheap, and if you stick to the XL cartridges it's also cheap to run: 4.3p for an A4 page of text and graphics is very good. While we can see the appeal of making occasional A3 prints, we'd rather buy a full A3 device or a better A4 MFP such as Epson's WorkForce WF-3520DWF.

Simon Handby

INKJET MFP

CANON Pixma MG6650



£100 inc VAT • From www.currys.co.uk

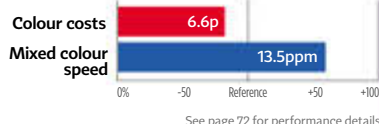
VERDICT

A great all-round MFP for the home

THIS SMART-LOOKING inkjet MFP can print, scan and make copies, but not send or receive faxes. There's no USB port for direct prints, but it does offer SD and Memory Stick card slots, as well as support for scanning to and printing from cloud services such as Dropbox. Wi-Fi support lets you share the printer easily over a home network too.

SPECIFICATIONS

TECHNOLOGY Thermal inkjet • **MAXIMUM PRINT RESOLUTION** 4,800x1,200dpi • **MAXIMUM OPTICAL SCAN RESOLUTION** 1,200x2,400dpi • **SIZE** 148x455x369mm • **WEIGHT** 6.4kg • **MAXIMUM PAPER SIZE** A4/legal • **WARRANTY** One year RTB • **DETAILS** www.canon.co.uk • **PART CODE** 9539B008AA



The compact design is attractive but it's not perfect, with a very short output tray. Access to the five ink cartridges is cramped and there's no physical keying to stop you inserting tanks in the wrong slot.

These grumbles aside, this is a great device. It costs only around £20 more than the excellent Pixma MG5650, yet adds faster print speeds, memory card slots, NFC support and touchscreen controls. That last addition is significant, as most mid-range Pixma devices make do with clumsily arranged buttons. The touchscreen is much better even if it isn't perfectly responsive.

The MG6650 is a reasonably swift printer, doling out our 25-page text test at a rate of 13.5ppm. Draft mode might save you some ink but at 13.8ppm it was barely any quicker. Colour printing was less impressive, with our page of complex graphics slowing to a middling 3.7ppm. Photo prints weren't especially rapid, either, with each 6x4in



borderless photo taking slightly more than two minutes. Text, colour graphics and photo prints were extremely good, as were black and colour photocopies.

The MG6650 took 10 seconds to complete a preview scan, 12 seconds for an A4 scan at 150dpi and 28 seconds to capture a 6x4in photo at 600dpi, all of which are reasonable results. Canon's TWAIN scan software is among the easiest and most comprehensive around, and quality was as excellent.

The XL versions of Canon's five-ink setup bring the cost of printing a page of mixed text and graphics to a reasonable 6.6p. Black ink makes up a steep 2.3p of this, but in practice we'd expect text-only printing to cost less.

Improved features and controls are worth a small premium over the MG5650, so the MG6650 is a Best Buy if you can stretch your budget. If you can't, you'll still be happy with its cheaper sibling.

Simon Handby

802.11ac RANGE EXTENDER

TP-LINK RE210 AC750 Wi-Fi Range Extender



£45 inc VAT • From www.ebuyer.com

VERDICT

A simple and cost-effective way to boost your Wi-Fi signal, but not as versatile as the competition

WI-FI DEAD ZONES can be a problem if you don't want to festoon your home with cables and Wi-Fi access points. TP-Link's latest range extender is designed to fill those gaps in your coverage with both 802.11n and 802.11ac Wi-Fi for fast speeds wherever you are.

The RE210 can extend both 2.4GHz and 5GHz networks simultaneously, and despite being limited to a theoretical maximum speed of 450Mbit/s compared with the 802.11ac standard's current 2,600Mbit/s maximum, the adaptor should still provide a speed boost to any 802.11ac devices on your network.

The RE210 is small and boxy, and plugs directly into a power socket. Its two wireless antennas can be rotated to create the best reception for your wireless gear, and a row of

LEDs helpfully indicate power, Wi-Fi activity and WPS pairing.

Setup should be as easy as plugging the RE210 into a mains socket between your router and wireless devices, then connecting to it over Wi-Fi and running the setup wizard. This scans for wireless networks automatically and gives you a choice of which to extend. Sadly, the IP address often refused to open during setup, and it took us several attempts to get a connection working, despite the LEDs suggesting everything was working correctly.

The single Gigabit Ethernet port in the bottom of the adaptor will let you connect a device such as a PC, smart TV or games console to your home network, whether it has Wi-Fi or not. Even if a device has built-in Wi-Fi, it may not be as quick as the RE210's 802.11ac standard, so using the Ethernet port may be an easy way to get smooth HD video streaming to your smart TV, for example.

To test the extender in a real-world situation, we took it home. Our kitchen is a

Wi-Fi dead zone, which is barely covered by the 2.4GHz band of the Virgin-supplied Super Hub 2 router in the living room and has no 5GHz coverage. With the extender set up in the hall, 2.4GHz throughput jumped from 1.3Mbit/s to 16.5Mbit/s. Speeds doubled again to 32.5Mbit/s on the 5GHz band.

When we connected to the extender and moved next to it, 2.4GHz speeds remained at 17.6Mbit/s, but in this position our network was quicker if we connected directly to our Virgin router. We saw much faster speeds through the extender on the 5GHz band, where it achieved 51.6Mbit/s versus 38.2Mbit/s from the router alone.

The RE210 will boost reception on any wireless network, but setup was fiddly. BT's Dual-Band Wi-Fi Extender 1200 is easier to set up and slightly faster for a few pounds more.

Tom Morgan



SPECIFICATIONS

WI-FI STANDARD 802.11ac • STATED SPEED 750Mbit/s combined • NETWORK PORTS 1 • WARRANTY Three years RTB • DETAILS uk.tp-link.com • PART CODE RE210

802.11ac RANGE EXTENDER

BT 11ac Dual-band Wi-Fi Extender 1200



£50 inc VAT • From shop.bt.com

VERDICT

Very fast and easy to set up – an ideal companion for any 802.11ac Wi-Fi router

802.11ac WI-FI SPEEDS have jumped considerably over the past year, although some wireless networking kit is significantly faster than others. If your broadband router is theoretically capable of 800Mbit/s or more, you don't want to hobble it with adaptors and range extenders that can't match these kind of speeds. BT's 11ac Dual-band Wi-Fi Extender 1200 is rated for up to 1,200Mbit/s, so should be able to extend the range of 802.11ac Wi-Fi networks without impacting their speeds. The extender works with any router, not just BT's.

The all-in-one device plugs straight into a wall socket, although its elongated shape may mean you struggle to make it fit if your plugs are too close to your skirting boards. The

wireless antennas are internal, so you can't angle them towards a particular area.

If your router supports WPS, setup is as easy as pressing a button on each device; the Extender will pair automatically with your router. LEDs on the front of the unit let you know if you're too close or too far from your router to get the best wireless speeds, so you won't have to reach for a Wi-Fi scanning app.

You can also set up the Extender by connecting to it directly over Wi-Fi or using an Ethernet cable. It lets you hook up any wired device to your Wi-Fi network, saving you from running network cables around the house, but the 10/100 port could potentially be a bottleneck with 802.11ac Wi-Fi speeds.

To test the Extender in a real-world situation we took it home, where there's a bit of a Wi-Fi dead spot in the kitchen. At the kitchen table, we usually get only 1.3Mbit/s from a Virgin-supplied Super Hub router, and no 5GHz coverage at all.

After installing the Extender about halfway between the router and the testing laptop, throughput on the 2.4GHz band jumped to 16.7Mbit/s. We could also connect on the 5GHz band, and saw impressive 36Mbit/s speeds. From the hall next to the extender, 2.4GHz performance was better if we connected directly to the router – we saw an average 26.6Mbit/s versus the Extender's 18Mbit/s. 5GHz performance was still superior through the Extender, however, at 57.6Mbit/s versus the router's 32.6Mbit/s.

We think you'll get a faster, more consistent wireless network with a Powerline network adaptor with Wi-Fi such as Devolo's dLAN 1200+ WiFi ac, but if you don't want to pay £100 to extend your Wi-Fi, BT's 11ac Dual-band Wi-Fi Extender 1200 is easy to set up and has impressive performance.

Tom Morgan



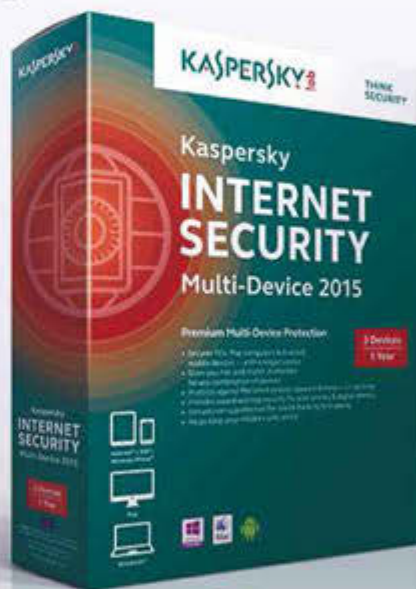
SPECIFICATIONS

WI-FI STANDARD 802.11ac • STATED SPEED 867Mbit/s • NETWORK PORTS 1 • WARRANTY Three years RTB • DETAILS home.bt.com • PART CODE 80462

KASPERSKY Lab



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Multi-Award Winning Internet Security

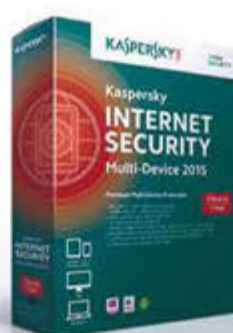


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NAS HARD DISK

HGST Deskstar NAS 6TB

COMPUTER
SHOPPER
BEST BUY

★★★★★

£218 inc VAT • From www.scan.co.uk

VERDICT

It uses more power than the competition, but it's undeniably fast

HARD DISKS OPTIMISED for NAS devices didn't really exist before Western Digital released the WD Red, a series of disks built for reliability and low operating temperatures. Now HGST has delivered the Deskstar NAS.

HGST's disk should have the edge in terms of performance, with a faster 7,200rpm spindle speed and 128MB of cache, compared to 5,400rpm and 64MB in the WD Red 6TB.

SPECIFICATIONS

CAPACITY 6TB • COST PER GIGABYTE £0.04 •
INTERFACE SATA3 • WARRANTY Three years RTB •
DETAILS www.hgst.com • PART CODE HDN726060ALE610

Large files 64.4MB/s
Small files 16.1MB/s

See page 72 for performance details



Western Digital does sell a 7,200rpm WD Red Pro, but it's not yet available in a 6TB capacity.

HGST matches Western Digital's generous three-year warranty, and is confident in the reliability of its disks, claiming that the disks can be active for 24 hours a day, seven days a week, and that each disk will last for one million hours of use between failures.

We can't test such longevity claims, but we can at least compare the Deskstar NAS 6TB with the WD Red 6TB in terms of power consumption and raw performance. With two of each disk installed in our reference two-bay NAS, a Synology DiskStation DS213air, the HGST disks drew 26W from the mains under load, whereas the total power draw with the WD disks installed was 21W.

The HGST disks have the edge in raw speed, though. With the disks configured in the standard Synology Hybrid RAID mode, and shared over a Gigabit Ethernet network

via SMB, the WD Red disks managed 35.1MB/s and 50.3MB/s in our large file write and read tests. With the Deskstar NAS disks, we saw 47.5MB/s and 81.3MB/s. It was a similar story in our small files test: the WD Red disks hit 11.2MB/s write and 14.1MB/s read speeds, while the Deskstar-equipped NAS managed faster 15MB/s and 17.2MB/s transfers.

There's little to separate the HGST and Western Digital NAS-oriented disks in terms of price, but based on our speed and power tests it appears you have a choice between speed and power drain. If you plan on running a NAS 24/7 and are concerned about power usage, the WD Red disks are probably still your best bet, but for home use where your NAS is frequently in low-power sleep mode, the extra speed from the HGST Deskstar NAS 6TB could be useful for quick file transfers and interruption-free media streaming.

Tom Morgan

RASPBERRY PI PRINTER

PIPSTA Pipsta

★★★★★

£84 inc VAT • From www.modmypi.com

VERDICT

A neat, but expensive, project printer for the Raspberry Pi

THERE ARE A huge number of software distributions, project tutorials and accessories available for the Raspberry Pi. Pipsta wants to add printing to that list. The Pipsta printer is a tiny kit comprising a flat-pack case for your Raspberry Pi and a thermal printing module that slots in the top, letting you print text and images on to receipt-style paper rolls.

The case is made from acrylic and slots together without screws, but it's a little fiddly. The Raspberry Pi screws into four standoffs in the base, while the printer module sits on top. Once assembled it's rather difficult to remove the top of the case, which could make using the GPIO headers for other projects tricky.

There's no neat way of organising your cables, as they snake out from every side. The

printer module's USB cable is also much longer than it needs to be, and although there's a little room beneath the Raspberry Pi to hide it, it's fiddly to pin it in place. The printer also needs a dedicated power adaptor, so you'll need two free plug sockets to run both printer and Pi.

Pipsta runs using Python scripts, which can be a little intimidating for anyone not used to the coding language, but thankfully detailed tutorials are available at bitbucket.org/ablesystems/pipsta/overview to get you started. There's no user-friendly interface to start printing; you have to edit the supplied demo scripts manually, or create your own from scratch. Dedicated Pi fans would argue this is all part of the fun, however.

The printer module uses a thermal printing process rather than laying down ink or toner, so you don't have to worry about refills. You're restricted to black and white images, but on the plus side prints are fast. Each print request takes a second or two to process, but rolls almost instantly out of the paper slot.



You have to tear your prints off the roll, much like you would with a receipt printer, so you may need to tidy them up with a pair of scissors. Print quality is above most receipt printers, but Pipsta fares better with text than it does with images.

Two rolls of paper are included with the kit; one is basic thermal paper, the other a roll of label paper. This doesn't have any backing paper, so you can tear off your print and slap it straight on to pretty much anything. The printer takes standard 36mm diameter, 57.5mm-wide thermal rolls, so buying replacements shouldn't be too difficult.

It's a novel way to experiment with Python scripting, but Pipsta is undeniably expensive. At £84 it's around the same price as an inkjet printer, yet can only print basic black-and-white text and images. The case design also means you're restricted when it comes to other Raspberry Pi projects, but if you like the idea of programming for your own little printer, Pipsta is still a fun learning experience.

Tom Morgan

SPECIFICATIONS

COMPATIBILITY Raspberry Pi A, B, B+, B2 • PRINTER TYPE Thermal • CONSUMABLES 36mm diameter, 57.5mm-wide thermal paper • DIMENSIONS 113x88x85mm • WARRANTY One year RTB • PART CODE PIPSTA



I2757FM



Play it large with the myPlay

Transfer games, photos, films, presentations and documents from your smartphone or other mobile device* in an impressively large size and in Full HD onto the myPlay display with its screen size of 68.6 cm / 27". View content together with your friends, family or colleagues in XXL. Thanks to the myPlay's integrated MHL™ interface (Mobile High- Definition Link) all content from your mobile devices gets "mirrored" onto the monitor – ideal for entertainment, social networking and work. A practical side effect: the mobile gadgets get charged at the same time. When size matters, show it with the myPlay from AOC (I2757FM model).

* Only devices with Micro-USB port conforming to the MHL™ Consortium's standards.

ZOTAC Zbox Nano CI321

COMPUTER
SHOPPERRECOMMENDED £133 inc VAT (barebones)/Approx £230 inc VAT
(Plus) • From www.kikatek.com

VERDICT

The compact Zbox Nano CI321 is easy to upgrade and powerful enough for simpler Windows tasks

LONG BEFORE INTEL'S Core i5-powered NUC arrived, Zotac's Zbox range of compact PCs were the go-to choice for anyone looking for a seriously small computer they could hide behind a monitor or under a desk. The Zbox Nano CI321 is the latest, and the first we've seen with an Intel processor at its heart rather than an AMD chip. It's available as either a barebones kit with no RAM or storage, or as a Plus model with 4GB of RAM and a 64GB SSD.

The Nano CI321 CPU is a 1.1GHz Celeron 2961Y, a dual-core chip based on Intel's Haswell architecture. It produces so little heat that the entire system can be passively cooled, so is completely silent. This is great news for anyone looking for a compact home theatre PC, but unfortunately anyone looking to get some serious work done will be disappointed by the chip's poor performance.

We tried running our 4K benchmarks, for example, but it took a solid 72 hours of grinding to complete. A final score of 11 is still three times faster than the Atom CPUs found in other Micro PCs manage, however. Our less demanding 1080p benchmarks were more than enough to tax the hardware, with a final score of 47; a £320 Core i3 laptop scores 100, which gives you an idea of this system's modest power. This is still sufficient for web browsing and Full HD video playback, though, as well as the odd bit of document work.

The Nano CI321 can't cope with modern gaming, either. With Intel's HD Graphics providing the processing power, the system could only manage a paltry 13.8fps in our Dirt Showdown test at 1,920x1,080 with 4x AA at High detail settings. Even reducing the settings to 1,280x720 with no anti-aliasing couldn't produce a smooth frame rate, with the CI321 chugging along at a 15.8fps average.

Unsurprisingly there are no overclocking settings in the BIOS, so there's no real scope for squeezing out extra performance, though you can at least adjust memory timings.

HIDE AWAY

The CI321 is barely any larger than a stack of four CDs, and ships with a VESA mounting bracket that lets you completely hide it from view behind a monitor. The case is made from metal, which helps dissipate heat from the passively cooled processor, and although it gets noticeably warm to the touch when in use it was never painfully hot.

Despite the compact size, there's still room inside for user-friendly memory and storage upgrades. The base plate, which is held in place by four screws, covers a laptop-sized RAM slot and a 2½in SSD slot, meaning you won't have to buy a costly M.2 or mSATA SSD to get started. The motherboard supports up to 16GB of DDR3 in a single slot, but we can't



find anywhere selling a single 16GB SO-DIMM, so 8GB is the maximum for the time being.

In the Plus model the RAM slot is occupied by 4GB of DDR3 RAM, and the 2½in disk slot is filled by an unbranded 64GB SSD, but anyone buying the basic version will have to fit their own RAM and storage. You would have to disassemble the unit completely to access the processor, but as it's soldered on to the motherboard there's not really any need to open the CI321 up any further.

PORTS REPORT

Connectivity isn't compromised either: there are two USB3 ports, two 3.5mm audio jacks and an SD card slot on the front, and two more USB3 ports, a single USB port, twin Ethernet ports, HDMI and DisplayPort video outputs and a Wi-Fi antenna on the back.

The Zbox Nano CI321 is a compact mini-PC that's far slower but around £100 cheaper than even a bottom-of-the-range Intel NUC. The Plus model is conveniently ready for a fresh install of Windows right out of the box, but the small SSD and meagre 4GB of RAM are on the low side for Windows. However, if you were to buy the barebones version and add your own 4GB of RAM and 64GB SSD, it would only cost around £185 in total, and if you were to install Linux you'd have a perfectly functional PC for simple tasks at a low price. Those who want proper computing power should save up for a Core i5 Intel NUC, but the Zbox Nano CI321 is still great value and wins a Recommended award.

Tom Morgan



SPECIFICATIONS

PROCESSOR SOCKET N/A • CHIPSET Intel • MEMORY SLOTS 1 • PCI-E x16 SLOTS 0 • USB PORTS 4x USB3, 1x USB • VIDEO OUTPUTS HDMI, DisplayPort • MAX 2½IN DRIVE BAYS 1 • MAX 3½IN DRIVE BAYS 0 • SIZE 125x127x37mm • WARRANTY One year RTB • DETAILS www.zotac.com • PART CODE ZBOX-CI321NANO-P

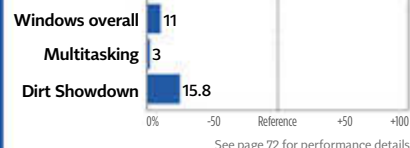


PHOTO-MANAGEMENT SOFTWARE

ADOBE Photoshop Lightroom 6

COMPUTER SHOPPER ★★★★★
BEST BUY £94 inc VAT •

From www.kikatek.com

VERDICT

A relatively modest update, but Lightroom still sets the standard for Raw processing

ADOBE LIGHTROOM HAS been our favourite photo editor ever since we first clapped eyes on version 1. Adobe already had Raw processing in the bag with its Adobe Camera Raw (ACR) engine for Photoshop, and Lightroom packaged it with elegant library management, printing and sharing facilities.

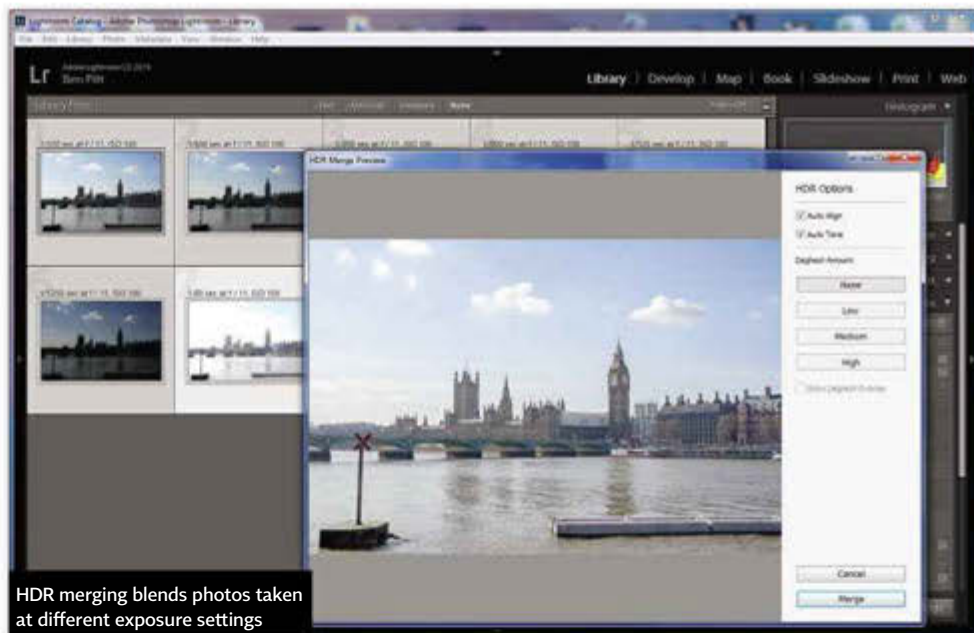
Version 6 brings relatively modest changes to the image-editing tools. It's now possible to modify the shape of a linear or radial graduated filter using brush strokes, which is ideal for darkening skies without inadvertently also darkening the tallest trees in a scene.

Lightroom has previously worked only on individual photos, but this update opens up the possibility to merge them. An HDR mode aligns and merges exposure-bracketed photos to produce an image with expanded dynamic range. There's minimal control over the process, with options to auto-align, auto-tone and de-ghost to remove repetitions of moving subjects. Enabling the latter for JPEGs resulted in some peculiar colour shifts and heavy noise, but it worked fine for Raw files.

Colour-processing merged HDR images is initially automatic, but it's delivered non-destructively through Lightroom's filters so it's easy to undo any changes. HDR merging often veers towards surreal overblown contrast, but the automatic results look surprisingly natural. For a more dramatic effect, it's usually just a matter of turning up the Clarity and Vibrance controls. You can also deselect Auto-tone and colour-correct from scratch.

Panorama stitching also makes its debut. Alignment and stitching is automatic, save for an auto-crop feature and options to build the composite image using three algorithms (Spherical, Cylindrical or Perspective) for a choice of fish-eye or rectilinear results.

Stitching 25 16-megapixel photos took 10 minutes, during which time our PC was very



slow to respond. Windows Task Manager revealed that it was our 8GB of RAM rather than the Core i7 870 processor causing a bottleneck. The resulting 164-megapixel DNG file was responsive to manipulate, though.

STITCHING TIME

We've previously had great success stitching hundreds of photos with the free Microsoft ICE utility. ICE took less than two minutes to stitch the same set of 25 photos, and only used 2GB of RAM. However, Lightroom has the advantage of being able to stitch Raw files and process colours and details afterwards.

The underlying Raw processing engine remains unchanged, but that's fine by us. Lightroom's Raw processing is one of the best, with precise colour correction, superb detail enhancement and noise reduction and a massive database of lens profiles to tackle lens distortion and vignetting.

Lightroom isn't just about photo processing; there are new photo-management features, too. A People view identifies faces in photos and allows the user to name them. It quickly began to identify the same faces in other photos within a set, and requested that we click to confirm each one. The interface is elegant, with the ability to see all the unnamed faces in a folder or collection, sort by suspected matches to a particular person or show all the unidentified faces in a photo. However, recognition of faces was often fairly wayward, and many faces were missed altogether. Recognition of family and friends would probably improve the more photos that were added, but we're not sure that we could be bothered to persevere with it.

Lightroom's web export facilities felt fairly redundant, with exports in Flash format and users left to find their own web-hosting service. Flash has now been replaced by HTML5, but the ability to host exported files on Adobe's servers is only available to Creative Cloud subscribers. They also get access to the Lightroom iOS and Android apps that provide basic editing and synchronisation of Collections with the web and the desktop app. It seems pretty stingy that people who buy Lightroom outright are excluded. Then again, the Creative Cloud Photography Plan bundles Lightroom and Photoshop CC for £103 per year, so going for a subscription rather than a perpetual licence may not be such a bad idea.

INTERFACE OFF

The interface has a couple of minor irritations. Folders are shown in tree view if they're imported that way, but otherwise it's by disk and then alphabetically. Search and filter facilities are comprehensive, but we'd prefer more flexible options to sort the library. The software doesn't allow duplicate files to be imported twice when they've been copied to a new location. There may be some sense to this but we'd like to have the option. These issues are few and far between, though. Overall, Lightroom is polished, efficient and well equipped to meet photographers' needs.

Less than £100 is remarkably good value for such a powerful application, and £59 to upgrade from version 5 isn't bad either. It's the Creative Cloud Photography Plan that gets our warmest recommendation, though. Most people will also need a layer-based editor for montages and design projects. In the past we've recommended Photoshop Elements, but at current prices it makes more sense to rent Photoshop CC and Lightroom.

Ben Pitt



SPECIFICATIONS

OS SUPPORT Windows 7 (SP1)/8/8.1 (64-bit); Mac OS X 10.8/10.9/10.10 • **MINIMUM CPU** Intel or AMD with 64-bit support • **MINIMUM GPU** 1GB, OpenGL 3.3, DirectX 10 • **MINIMUM RAM** 2GB (8GB recommended) • **HARD DISK SPACE** 2GB • **DETAILS** www.adobe.com/uk • **PRODUCT CODE** 65237576

CROWDFUNDED RACING SIMULATION

SLIGHTLY MAD STUDIOS

Project CARS



£24 inc VAT • From www.cdkeys.com

VERDICT

Ambitious and beautiful, but not as fun nor as finished as it should be

SLIGHTLY MAD STUDIOS turned to crowdfunding in 2012 to finance a racing game without pressure from the huge publishers that funded its previous efforts. In the intervening years, what started life as a serious simulation has morphed into something that more casual players can enjoy, yet Project CARS has still managed to retain its hardcore, PC gaming roots.

There's a decent, rather than huge, car list, with road cars such as the Caterham Seven and Audi's R8 V10 Plus, fictional Formula 1 and Formula 3-style open-wheel racers, tin tops such as the Ford Sierra RS500 and GT-class cars such as the Ginetta G55 and Aston Martin Vantage GT3. All are beautifully rendered and accessible from the off, with no need to unlock them through play.

Even the career mode lets you start anywhere you want, skipping championships you don't fancy. It's a very open model and one many gamers will appreciate, even if it does diminish the feeling of progression.

STEERING COMMITTEE

Every race is subject to a robust and unforgiving physics model that veers towards the impenetrable on some cars, but often in strange ways. There's a lot of fun to be had behind the wheel of a high-speed Formula C racer, but step down to Formula Rookie and steering feels completely disconnected from the road. Drifting through your opening lap in a front-wheel-drive Renault Clio Cup car on cold tyres is superb, but classics such as the

1967 Lotus 49 Formula 1 manage to be both very tail-happy yet tiresomely understeery at the same time. Project CARS' GT3 and road cars just aren't as fun to drive as they are on Assetto Corsa, and single-seaters lack the thrill you get from iRacing. It's not a bad model by any means, but isn't quite as visceral.

Inexperienced drivers will appreciate the numerous driving aids, with gamepad players getting a surprising amount of customisation options, but it will take a lot of tweaking to find your perfect setup. Racing wheel users will also struggle, as we couldn't find a force feedback setting that worked with all cars at all times. You have to make changes from the main menu, meaning leaving a race session, tweaking your settings and then starting a new session to test them.

Beyond career mode, offline single player is hugely customisable. You can choose session length, opponent difficulty, time of day and weather conditions. Project CARS is at its best when transitioning between wet and dry conditions, when the track feels different on each lap as you hunt for grip. Push too hard and your tyres will wear, making the end of every race a real nail-biter as more conservative rivals start to catch you up.

There's a wide selection of UK tracks, with the rarely seen Cadwell Park and Snetterton circuits making the cut alongside Silverstone, Brands Hatch and Donington Park. Overseas there are representations of Spa, Le Mans, Monza and Road America. They're all beautifully rendered, but several start/finish

lines, pit lane entries and exit speed limit lines were out of place by up to 100 metres, making a difference to the way races play out. This may seem pedantic, but a racing simulation should be as true to life as possible.

Depending on track and car combinations, the AI competitors can range from fearsome rivals to moronic amateurs. It's particularly bad during opening laps, as the AI slows to a standstill as it tries to figure out where to go. AI cars frequently stick to the white boundary lines instead of cutting corners for faster lap times. This lack of consistency really upsets the single-player experience, and for each track and car combination you'll need to adjust the difficulty settings to ensure you're getting a proper challenge.

CHAOS THEORY

Online racing doesn't feel hugely refined either, at least on a PC; players on poor connections leap all over the track causing chaos, and the server list is unclear about what sort of game you're joining. When you eventually get on the track and past the chaos of turn one, there's fun to be had, but getting there is currently too difficult and confusing.

Maxed out on a high-spec PC, Project CARS looks stunning, with particularly eye-catching lighting and dynamic weather effects. Some of the 2D trees on some tracks look a little iffy, but you'll still be immersed if you're driving from the in-helmet view. Sound is more of a mixed bag, however. While all the cars definitely sound something like their real-life counterparts, many of them exhibit an unpleasant, synthesised characteristic.

Project CARS does a lot of things right: it looks stupendous and its handling model is, for the most part, very good. However, the tedium of racing against AI halfwits and getting your force feedback settings just right take away from the enjoyment. Right now, buyers will feel more Try-hard than Coulthard.

Michael Passingham

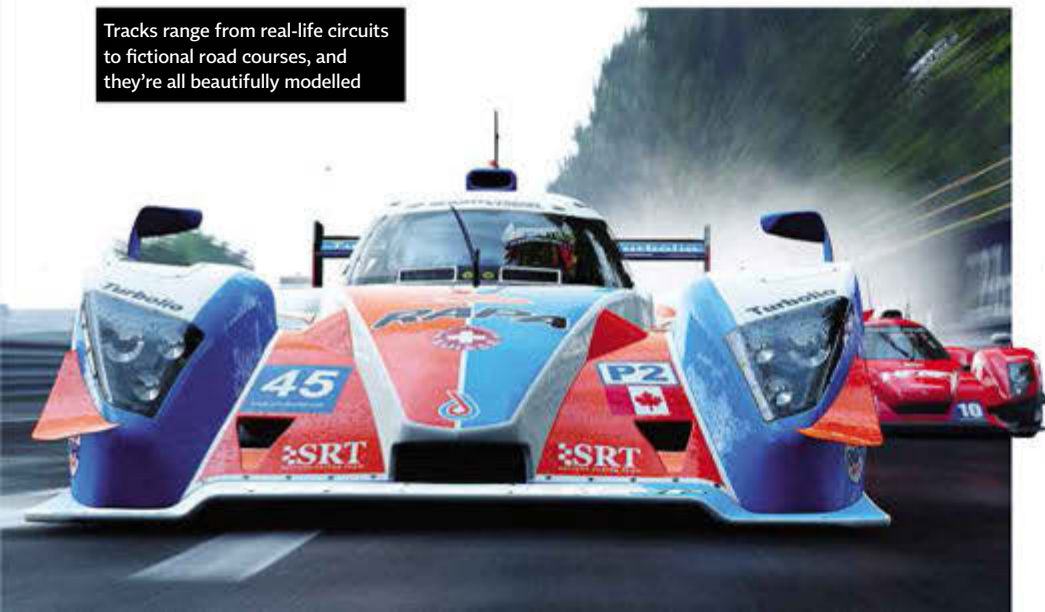
SPECIFICATIONS

AVAILABLE FORMATS PC, Xbox One, PS4 • **OS SUPPORT** Windows Vista, 7, 8, 8.1 • **MINIMUM CPU** 2.66GHz Intel Core 2 Quad Q8400, 3GHz AMD Phenom II X4 940 • **MINIMUM GPU** Nvidia GeForce GTX 260, ATI Radeon HD 5770 • **MINIMUM RAM** 4GB • **HARD DISK SPACE** 25GB • **DETAILS** projectcarsgame.com • **PRODUCT CODE** Project CARS



There's a wide variety of cars available to drive, but they're not all fun

Tracks range from real-life circuits to fictional road courses, and they're all beautifully modelled



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The Witcher 3:
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SHOPPER

★★★★★

BEST BUY

£50 inc VAT • From www.gog.com

VERDICT

A great plot, a fantastic yet believable world,
and beautifully drawn characters

RPG MECHANICS MAY have been purloined by nearly every game under the sun in recent years, but there's a lot more to the genre than loot, experience points and the slow grind to god-like abilities. The other half of the equation is a fully fleshed out character, rather than just a faceless combatant. The Witcher 3 has no character-creation system, and no millions of nose, hair and eye-colour combinations. You are simply Geralt of Rivia, a hulking great slab of machismo and dry wit.

Generating a hero of your own making in the typical pen-and-paper model can leave your character lacking a place in the world they inhabit. Even allowing for the usual connivances of prophecies and amnesia, you start as a nobody who knows no-one. Geralt is the complete opposite.

A figure of renown throughout the Northern Kingdoms, he has a rich backstory and complex relationships with the other major players. You may want to read the plot synopsis of the first two games, but it's not strictly necessary to enjoy this epic tale.

HORSE TRADING

It may be story- and character-driven, but there's a huge amount of freedom available to you outside of the main storyline. The Northern Kingdoms of 'The Continent' make up a huge explorable area, strewn liberally with castles, villages, ruins and more. Thankfully Geralt's horse Roach comes running at a whistle. The horse is fast and can gallop to outrun most enemies, but you can fight from horseback if you choose.

The world has a good share of extra content too, with horse racing, a complex card



Geralt may be a mercenary, but he has a moral code of sorts and motivations that most will understand

game-within-the-game to master, treasure hunts and huge battles with epic beasts. Geralt has enhanced Witcher senses, which let him see clues when searching for items and footprints when tracking animals. This possibly makes things too easy, as we'd have liked a little more detective work at times.

Most hunts result in a fight but Geralt is more than able to handle himself, with a steel sword for fighting humans and a silver one for monsters. The combat system is pretty simple, with light and heavy attacks plus parries. So-called Signs also let you use defensive and offensive magic, letting you throw down temporary defensive bubbles, traps that inflict area-specific damage on enemies, and bombs. An encounter with a Noonwraith forced a strategic combat approach, employing traps to give her corporeal form that let us land physical attacks: CD Projekt Red has clearly striven to avoid identikit combat encounters.

The fighting isn't exceptional stuff, but it flows nicely and there are some brutal finishers. You can die quickly if you're not concentrating, and taking out bigger groups requires some thought. You can upgrade your skills, including some neat tricks such as deflecting arrows with your sword.

LOVER MAN

Geralt may mainly be a fighter, but he's also a bit of a lover. With only a single male lead, and one who's undoubtedly an attractive man to many women in his world, it's not that easy to level the playing field – as in, say, Mass Effect, which has come under scrutiny for its depiction of women. That being said, there are numerous powerful female protagonists, so

Geralt doesn't always get things his own way. It's not just the big players that get great treatment, though; even the smaller quest givers often have a twist in their tale, with voice acting of a quality to make you care.

Quests and monster contracts earn you experience, and you can quickly level up your skills, allowing you to put your own spin on Geralt's capabilities. Major quests come with their own recommended levels for tackling them, so you know how many sidequests you need to take on in order to make progress.

Although you'll gradually become stronger, to be truly powerful you'll need to prepare Geralt properly before a big fight. There are lots of temporary buffs you can set up, with grindstones giving bonus weapon damage and standing stones doing the same for your magical abilities. Potions can be mixed from alchemical ingredients, and your blades can be coated in poison. This preparation really adds to the sense of anticipation for a big fight.

DRAMATIC EFFECT

The game looks fantastic, with a world that's packed with small details and which looks and feels inhabited. The day-night cycle and dynamic weather make for some dramatic vistas, from bleak rain-swept battlefields to sunlight dappling through cherry blossom.

Our only real complaints are that Geralt's movement feels a little twitchy. In combat it feels fine, but when simply exploring it's easy to overshoot your intended destination unless you're easy on the controls. There's the usual headache of having to search and loot everything you find, forcing you to manage your bloated inventory at regular intervals.

These are minor issues, though. Geralt is a likeable protagonist who bows to no-one, but his actions are motivated by worthy ideals. He sits at the core of the game, the world around him is connected to him and he feels at home within it. We think you will too.

Seth Barton

Geralt is an accomplished fighter, becoming practically superhuman if properly prepared



SPECIFICATIONS

AVAILABLE FORMATS PC, PlayStation 4, Xbox One • OS SUPPORT 64-bit Windows 7 or 8 • MINIMUM CPU Intel quad-core 3.3GHz or AMD quad-core 3GHz • MINIMUM GPU Nvidia GTX 660 or AMD HD 7870 • MINIMUM RAM 6GB • HARD DISK SPACE 40GB • DETAILS thewitcher.com/witcher3 • PRODUCT CODE 292030

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Choosing a ...

Laptop computer

01 A basic laptop costing around £300 will run everyday office, multimedia and education software, but it won't be suitable for 3D gaming. Many laptops at this price have a 15.4in screen and weigh around 2.4kg, so they're best used around the house and for occasional journeys.

02 If you want to play modern games, you'll need a laptop that has a dedicated graphics chip such as the Nvidia GeForce GTX 860M. Good gaming laptops tend to have large 17in screens and weigh around 3kg, so they're best suited to the home.

03 If you want a laptop that you can take everywhere, look for a model that weighs less than 2kg. For the best portability, look for one with an 11in or 13in screen. In general, the smaller and lighter the laptop, the more expensive it is, especially if you want a model with plenty of processing power.

04 Battery life is extremely important for a laptop. We'd expect all but the biggest and heaviest to last for at least five hours on a single charge, but for an ultra-portable that you carry everywhere, eight hours and above is more desirable.

05 Laptops use the mobile versions of processors to conserve power, and these lag behind desktop chips for performance. For a budget laptop, an Intel Core i3 processor will do the job, but if you want better performance, look for an Intel Core i5 or Core i7 model instead. We recommend a minimum of 4GB of RAM, although 8GB is better for multitasking.

06 Most budget and mid-range laptops have a regular hard disk for storage. You want at least 500GB, but 1TB or more is better. SSDs have faster performance, making your computer much quicker to boot. SSD capacity is lower, though, and you'll need at least 128GB.

07 Netbooks are a type of small, low-cost ultra-portable laptop. They're fine for light use, but avoid them if you want to do complicated tasks.

PCs



CHILLBLAST Fusion Raptor



£1,129 inc VAT • www.chillblast.com

The Chillblast Fusion Raptor comes in a gorgeous case and manages to successfully marry great application performance and scintillating gaming gusto. It uses some impressive components and is great value.

PROCESSOR Quad-core 4.4GHz Intel Core i7-4790K (overclocked) • **RAM** 16GB • **FRONT USB PORTS** 2x USB3 • **REAR USB PORTS** 2x USB, 4x USB3 • **TOTAL STORAGE** 120GB SSD, 2TB hard disk • **GRAPHICS CARD** 2GB MSI GeForce GTX 960 Gaming 2G • **DISPLAY** None • **OPERATING SYSTEM** Windows 8.1 • **WARRANTY** Five years (Three years collect and return, two years RTB) • **DETAILS** www.chillblast.com • **PART CODE** Fusion Raptor • **FULL REVIEW** May 2015



APPLE Mac Mini (2014)



£569 inc VAT • store.apple.com/uk

The Mac Mini (2014) has great performance for a compact system. It has stunning looks thanks to its beautiful curved edges made from a single block of aluminium. It's a worthy update to the Mac Mini range and a good choice for those looking for their first Apple Mac computer.

PROCESSOR Dual-core 2.6GHz Intel Core i5-4278U • **RAM** 8GB • **FRONT USB PORTS** 0 • **REAR USB PORTS** 4 • **TOTAL STORAGE** 1TB hard disk • **DISPLAY** None • **OPERATING SYSTEM** Mac OS X 10.10 • **WARRANTY** One year RTB • **DETAILS** www.apple.com • **PART CODE** Mac Mini A1357 • **FULL REVIEW** Feb 2015



PALICOMP i5 Devil Blaster



£700 inc VAT • www.palicom.co.uk

Palicom has created an eminently powerful system for the money. The i5 Devil Blaster has terrific gaming performance and the system's overclocked i5-4690K processor provides great application performance as well. A decent monitor rounds off a great-value system.

PROCESSOR Quad-core 4.5GHz Intel Core i5-4690K (overclocked) • **RAM** 8GB • **FRONT USB PORTS** 1x USB3, 1x USB • **REAR USB PORTS** 4x USB3, 2x USB • **TOTAL STORAGE** 1TB hybrid hard disk • **GRAPHICS CARD** 2GB PowerColor AMD Radeon R9 270X • **DISPLAY** 24in Iiyama ProLite E2483HS • **OPERATING SYSTEM** Windows 8.1 • **WARRANTY** Three years RTB, one year parts • **DETAILS** www.palicom.co.uk • **PART CODE** HAS8 • **FULL REVIEW** Dec 2014



LAPTOPS



ASUS Zenbook UX305



£650 inc VAT • www.currys.co.uk

The UX305 is Asus's first laptop that runs Intel's new low-power Core M processors. Weighing just 1.2kg and 12mm thick, it's one of the thinnest and lightest laptops we've ever tested. Its performance won't set the world alight, but if you're after a portable work machine, look no further.

PROCESSOR Dual-core 0.8GHz Intel Core M-5Y10c • **RAM** 8GB • **SIZE** 324x226x12mm • **WEIGHT** 1.2kg • **SCREEN SIZE** 13.3in • **SCREEN RESOLUTION** 1,920x1,080 • **GRAPHICS ADAPTOR** Intel HD 5300 • **TOTAL STORAGE** 128GB SSD • **OPERATING SYSTEM** Windows 8.1 • **PARTS AND LABOUR WARRANTY** One year collect and return • **DETAILS** www.asus.com • **PART CODE** UX305FA(MS)-FC061H • **FULL REVIEW** Jun 2015



ACER Aspire V Nitro VN7-591G



£850 inc VAT • www.saveonlaptops.co.uk

Acer's re-entry into the world of stylish gaming laptops is a massive success. The Aspire V Nitro's attractive chassis, powerful components and competitive price make it a great laptop for anyone looking for a performance notebook.

PROCESSOR Quad-core 2.5GHz Intel Core i7-4710HQ • **RAM** 8GB • **SIZE** 389x257x24mm • **WEIGHT** 2.4kg • **SCREEN SIZE** 15.6in • **SCREEN RESOLUTION** 1,920x1,080 • **GRAPHICS ADAPTOR** Nvidia GeForce GTX 860M • **TOTAL STORAGE** 1TB hard disk (with 8GB SSD cache) • **OPERATING SYSTEM** Windows 8.1 • **WARRANTY** One year RTB • **DETAILS** www.acer.co.uk • **PART CODE** NX.MQLEK.002 • **FULL REVIEW** Apr 2015



TOSHIBA Chromebook 2 (CB30-B-104)



£270 inc VAT • www.johnlewis.com

Toshiba's Chromebook 2 is the first budget Chromebook on sale in the UK with a Full HD screen. This increases the price a little but we think it's absolutely worth it. With so much extra real estate, you can fit more items on the screen and get more done. The machine is lighter and has better battery life than its predecessor, too, making it our current favourite Chromebook.

PROCESSOR Dual-core 2.16GHz Intel Celeron N2840 • **RAM** 4GB • **SIZE** 320x214x19mm • **WEIGHT** 1.35kg • **SCREEN SIZE** 13.3in • **SCREEN RESOLUTION** 1,920x1,080 • **GRAPHICS ADAPTOR** Intel HD Graphics • **TOTAL STORAGE** 16GB SSD • **OPERATING SYSTEM** Google Chrome OS • **PARTS AND LABOUR WARRANTY** One year RTB • **DETAILS** www.toshiba.co.uk • **PART CODE** PLM02E-000003EN • **FULL REVIEW** May 2015



Choosing a ... Smartphone

01 A smartphone's operating system (OS) dictates its basic features and which third-party software you can install. There are three main contenders: Apple's iOS, which is found on the iPhone; Google's Android, which is used by various handset manufacturers; and Windows Phone 8, which is becoming more widespread and is a great alternative to Apple's and Google's operating systems. Apple iOS and Google Android have the most apps available but Windows Phone is slowly catching up.

02 All smartphones have colour screens, but their resolutions vary. Basic models have 800x480 pixels, but text can be indistinct. Look for a display that has at least 1,280x720 pixels so it's easy to browse web pages. Don't worry too much about built-in media players or Office document editors – you can always install apps to replace these with better versions later.

Cameras are improving in smartphones, and resolutions have increased to as high as 20 megapixels. The image quality of smartphone cameras has improved tremendously in recent years.

03 Barely any modern smartphones have a physical keyboard for entering text: they almost exclusively use touchscreens. Physical keyboards can aid heavy emailing, but touchscreen keyboards work just as well now. Android smartphones and iPhones running iOS 8 let you install a variety of custom onscreen keyboards so you can find one that suits you.

04 Be careful when choosing a mobile contract. Look for one with a large data allowance if you want to use the internet regularly or you've set your phone to synchronise your contacts, calendar and email through online services such as Google's.

Built-in Wi-Fi can help you avoid high data charges by connecting to the internet through wireless hotspots when you're out, or your router when you're at home. Android and iPhone handsets can operate as wireless hotspots, enabling you to connect your laptop to the web over your mobile data connection. There may be an extra charge for this.

SMARTPHONES



SAMSUNG Galaxy S6

★★★★★

£560 SIM-free, free on £40-per-month contract • www.carphonewarehouse.com (SIM-free & contract)

The Galaxy S6 is one of Samsung's best phones yet. Made of metal, its performance is among the best we've seen and its 2,560x1,440 screen looks gorgeous. If you want a phone to really turn heads, though, there's also the curvy Galaxy S6 Edge.

PROCESSOR Quad-core 2.1GHz & quad-core 1.5GHz Samsung Exynos 7420 • SCREEN SIZE 5.1in • SCREEN RESOLUTION 2,560x1,440 • REAR CAMERA 16 megapixels • STORAGE 32GB • WIRELESS DATA 4G • SIZE 143x70x6.8mm • WEIGHT 132g • OPERATING SYSTEM Android 5.0 • WARRANTY One year RTB • DETAILS www.samsung.com/uk • PART CODE SM-G920F • FULL REVIEW Jul 2015



SAMSUNG Galaxy Note 4

★★★★★

£500 SIM-free, free on £39-per-month contract • www.carphonewarehouse.com (SIM-free & contract)

Samsung started the phablet market with its original Note and the Note 4 is the best model yet. A huge screen with a high resolution, plenty of power, tons of battery life and a stylus all combine to make this one of the best phablets you can buy.

PROCESSOR Quad-core 2.7GHz Qualcomm Snapdragon 805 • SCREEN SIZE 5.7in • SCREEN RESOLUTION 2,560x1,440 • REAR CAMERA 16 megapixels • STORAGE 32GB • WIRELESS DATA 4G • SIZE 154x79x8.5mm • WEIGHT 176g • OPERATING SYSTEM Android 4.4.4 • WARRANTY One year RTB • DETAILS www.samsung.com/uk • PART CODE SM-N910F • FULL REVIEW Jan 2015



APPLE iPhone 6

★★★★★

£539 SIM-free, free on £35-per-month contract • store.apple.com/uk (SIM-free), www.carphonewarehouse.com (contract)

It took Apple a while, but it finally increased screen size with the iPhone 6 range. Now with a 4.7in display, a fast processor, improved battery life and iOS 8.3, the iPhone 6 is an improvement in every way on the iPhone 5s.

PROCESSOR Dual-core 1.4GHz Apple A8 • SCREEN SIZE 4.7in • SCREEN RESOLUTION 1,334x750 • REAR CAMERA 8 megapixels • STORAGE 16GB • WIRELESS DATA 4G • SIZE 138x67x6.9mm • WEIGHT 129g • OPERATING SYSTEM iOS 8.3 • WARRANTY One year RTB • DETAILS www.apple.com/uk • PART CODE iPhone 6 • FULL REVIEW Dec 2014



SONY Xperia Z3 Compact

★★★★★

£328 SIM-free, free on £27.50-per-month contract • www.handtec.co.uk (SIM-free), www.carphonewarehouse.com (contract)

With its incredible 20-hour battery life and fast performance, the Sony Xperia Z3 Compact brings flagship features to a smaller handset at a great price.

PROCESSOR Quad-core 2.5GHz Qualcomm Snapdragon 801 • SCREEN SIZE 4.6in • SCREEN RESOLUTION 1,280x720 • REAR CAMERA 20.7 megapixels • STORAGE 16GB • WIRELESS DATA 4G • DIMENSIONS 127x65x8.6mm • WEIGHT 129g • OPERATING SYSTEM Android 4.4 • PART CODE Sony D5803 • DETAILS www.sony.co.uk • FULL REVIEW Jan 2015



HTC Desire Eye

★★★★★

£330 SIM-free, free on £26-per-month contract • www.handtec.co.uk (SIM-free), www.smartphonecompany.co.uk (contract)

With its two 13-megapixel cameras, the Desire Eye is great for photography and selfie fans alike. It has quick internals to match HTC's flagship One (m8), and the bright, dual-colour unibody design looks great too.

PROCESSOR Quad-core 2.3GHz Qualcomm Snapdragon 801 • SCREEN SIZE 5.2in • SCREEN RESOLUTION 1,920x1,080 • REAR CAMERA 13 megapixels • STORAGE 16GB • WIRELESS DATA 4G • SIZE 152x74x8.5mm • WEIGHT 154g • OPERATING SYSTEM Android 4.4 • DETAILS www.htc.com/uk • PART CODE HTC Desire Eye • FULL REVIEW Mar 2015



MOTOROLA Moto G (2nd Gen.)

★★★★★

£149 SIM-free, Free on £11.50-per-month contract • www.motorola.co.uk (SIM-free), www.idmobile.co.uk (contract)

The Moto G just got even better. Now available with a larger screen, better camera, longer battery life and 4G, the new Moto G is the best budget smartphone of the year.

PROCESSOR Quad-core 1.2GHz Qualcomm Snapdragon 400 • SCREEN SIZE 5in • SCREEN RESOLUTION 1,280x720 • REAR CAMERA 8 megapixels • STORAGE 8GB • WIRELESS DATA 4G • DIMENSIONS 141x70x11mm • WEIGHT 149g • OPERATING SYSTEM Android 4.4 • PART CODE XT1068 • DETAILS www.motorola.co.uk • FULL REVIEW Jan 2015



MOTOROLA Moto E (2nd Gen.)

★★★★★

£100 SIM-free, free on £10.50-per-month contract • www.carphonewarehouse.com (SIM-free & contract)

The new 4G Moto E is a smartphone bargain. It feels just as well made as the Moto G and its web-browsing performance isn't that far behind, either.

PROCESSOR Quad-core 1.2GHz Qualcomm Snapdragon 410 • SCREEN SIZE 4.5in • SCREEN RESOLUTION 960x540 • REAR CAMERA 5 megapixels • STORAGE 8GB • WIRELESS DATA 4G • SIZE 130x67x12.3mm • WEIGHT 145g • OPERATING SYSTEM Android 5.0.2 • WARRANTY One year RTB • DETAILS www.motorola.co.uk • PART CODE XT1505 • FULL REVIEW Jun 2015



NOKIA Lumia 930

★★★★★

£270 SIM-free, free on £32-per-month contract • www.expansys.com (SIM-free), shop.ee.co.uk (contract)

The Lumia 930 benefits from a fantastic Full HD OLED screen, excellent performance and beautiful Nokia build quality. It also runs Windows Phone 8.1, which brings several improvements to the operating system.

PROCESSOR Quad-core 2.2GHz Qualcomm Snapdragon 800 • SCREEN SIZE 5in • SCREEN RESOLUTION 1,920x1,080 • REAR CAMERA 20 megapixels • STORAGE 32GB • WIRELESS DATA 4G • DIMENSIONS 137x71x9.8mm • WEIGHT 167g • OPERATING SYSTEM Windows Phone 8.1 • PART CODE RM-1045 • DETAILS www.nokia.com • FULL REVIEW Oct 2014



NOKIA Lumia 735

★★★★★

£159 SIM-free, free on £15.50-per-month contract • www.expansys.com (SIM-free), www.carphonewarehouse.com (contract)

One of the best Lumia phones we've seen, and also quite a bargain. With its great camera, stunning OLED display and longer-lasting battery, this is a great budget Windows Phone for anyone.

PROCESSOR Quad-core 1.2GHz Qualcomm Snapdragon 400 • SCREEN SIZE 4.7in • SCREEN RESOLUTION 1,280x720 • REAR CAMERA 6.7 megapixels • STORAGE 8GB • WIRELESS DATA 4G • SIZE 146x74x8.9mm • WEIGHT 149g • OPERATING SYSTEM Windows Phone 8.1 • WARRANTY One year RTB • DETAILS www.nokia.com • PART CODE RM-1039 • FULL REVIEW Mar 2015



LG G3

★★★★★

£270 SIM-free, free on £28.50-per-month contract • www.ebuyer.co.uk (SIM-free), www.o2.co.uk (contract)

It's about to be replaced by the G4 (see page 33), but the G3 is still a great choice. Its 5.5in 2,560x1,440 screen looks great and its excellent battery life will see you through the day.

PROCESSOR Quad-core 2.5GHz Qualcomm Snapdragon 801 • SCREEN SIZE 5.5in • SCREEN RESOLUTION 2,560x1,440 • REAR CAMERA 13 megapixels • STORAGE 16GB • WIRELESS DATA 4G • SIZE 146x74x8.9mm • WEIGHT 149g • OPERATING SYSTEM Android 4.4 • DETAILS www.lg.com/uk • PART CODE LG G3 D855 • FULL REVIEW Sep 2014



Choosing a...

Monitor

01 A basic 24in LCD monitor costs around £100. It will be fine for typical Windows work but is likely to have poor viewing angles, so you'll need to sit straight on to achieve the best picture quality. Its colour accuracy may not be very good, though.

02 A VGA input lets you use the monitor with any PC, but the quality may not be as good as it is over DVI or HDMI. Both are digital connections and require a compatible graphics card but they avoid the need for digital-to-analogue or analogue-to-digital conversions, which can reduce image quality. A digital connection achieves the best picture automatically, so you won't have to adjust clock or phase settings as you do with analogue connections.

Many DVI and all HDMI connections support HDCP, which lets you watch protected video content, such as Blu-ray movies. DisplayPort is becoming more popular, but you'll need a graphics card with a DisplayPort output (mini or full-size) to use this input on your monitor.

03 A larger monitor will be easier on the eye and may have a higher resolution. Most monitors have resolutions of at least 1,920x1,080 (1080p), which provide lots of room for working with multiple windows at the same time. For even higher resolutions, you'll need a larger display. Some 27in and 30in screens have 2,560x1,600 or even 4K resolutions. You'll need a graphics card with a dual-link DVI output and a dual-link DVI cable or either HDMI or DisplayPort to use a monitor at these resolutions.

04 If you want better picture quality, look for a monitor with a high contrast ratio. The higher the ratio, the whiter the whites and the blacker the blacks. You'll also be able to see more fine detail in images with high contrast levels. Viewing angles are important, as wider angles mean you don't have to sit directly in front of the monitor to get the best picture. Wider viewing angles also allow more people to view the screen at the same time.

Fast response times reduce ghosting, but don't be dazzled by the numbers. A response time of 25ms or quicker is fine for all applications.

PHOTOGRAPHY

COMPACT SYSTEM CAMERA	COMPUTER SHOPPER RECOMMENDED ★★★★★ SAMSUNG NX3000 £249 inc VAT • www.ukdigitalcameras.co.uk With its high image quality, wealth of features and slim design, the NX3000 is an excellent camera. Better still, at its current low price it's an unbelievable bargain. Buy one while you can. SENSOR RESOLUTION 20 megapixels • SENSOR SIZE 23.5x15.7mm (APS-C) • FOCAL LENGTH MULTIPLIER 1.5x • VIEWFINDER None • LCD SCREEN 3in (460,800 dots) • OPTICAL ZOOM (35mm-EQUIVALENT FOCAL LENGTHS) 3.1x (24-75mm) • 35mm-EQUIVALENT APERTURE f/5.2-8.4 • LENS MOUNT Samsung NX • WEIGHT 386g • DIMENSIONS 67x126x78mm • WARRANTY One year RTB • DETAILS www.samsung.com/uk • FULL REVIEW Jan 2015	
COMPACT CAMERA	COMPUTER SHOPPER BEST BUY ★★★★★ NIKON Coolpix S9700 £160 inc VAT • www.buyacamera.co.uk This compact camera packs in a 30x zoom lens, Wi-Fi, GPS and slow-motion video. Its has a comprehensive set of controls, but it's the image quality that really impresses, achieving decent shots in tough conditions. SENSOR RESOLUTION 16 megapixels • SENSOR SIZE 1/2.3in • VIEWFINDER None • LCD SCREEN 3in (921,000 dots) • OPTICAL ZOOM (35mm-EQUIVALENT FOCAL LENGTHS) 30x (25-750mm) • 35mm-EQUIVALENT APERTURE f/21-36 • WEIGHT 235g • DIMENSIONS 66x110x34mm • WARRANTY Two years RTB • DETAILS www.nikon.co.uk • FULL REVIEW Nov 2014	
ULTRA-ZOOM CAMERA	COMPUTER SHOPPER BEST BUY ★★★★★ PANASONIC Lumix DMC-FZ200 £329 inc VAT • www.johnlewis.com This ultra-zoom camera has a big 25-600mm zoom range and maintains a fast F2.8 aperture across the whole focal range, so you can shoot in low-light conditions without too much worry. SENSOR RESOLUTION 12.1 megapixels • SENSOR SIZE 6.2x4.6mm (1/2.3in) • VIEWFINDER Electronic • LCD SCREEN 3in • OPTICAL ZOOM (35mm-EQUIVALENT FOCAL LENGTHS) 24x (25-600mm) • 35mm-EQUIVALENT APERTURE f/5.5 • WEIGHT 588g • DIMENSIONS 87x125x110mm • WARRANTY One year RTB • DETAILS www.panasonic.com/uk • FULL REVIEW Feb 2013	
SLR CAMERA	COMPUTER SHOPPER BEST BUY ★★★★★ NIKON D7100 £899 inc VAT • www.wexphotographic.com The Nikon D7100 has brilliant image quality, ergonomics and autofocus. It's long been our top pick, and even though it's just been replaced with the D7200 falling prices still make this an excellent choice. SENSOR RESOLUTION 24 megapixels • SENSOR SIZE 23.5x15.6mm (APS-C) • FOCAL LENGTH MULTIPLIER 1.52x • VIEWFINDER Optical • LCD SCREEN 3.2in • OPTICAL ZOOM (35mm-EQUIVALENT FOCAL LENGTHS) 27-157mm • 35mm-EQUIVALENT APERTURE N/A • LENS MOUNT F-mount • WEIGHT 1.2kg • DIMENSIONS 108x137x160mm • WARRANTY Two years RTB • DETAILS www.nikon.co.uk • FULL REVIEW Oct 2013	
SLR CAMERA	COMPUTER SHOPPER BEST BUY ★★★★★ CANON EOS 700D £479 inc VAT • www.wexphotographic.com This superb all-rounder avoids the flaws of its predecessors. Photos taken with its 18-55mm kit lens were consistently better than those of similarly priced cameras, and there's a wide range of affordable extra lenses. SENSOR RESOLUTION 20 megapixels • SENSOR SIZE 22.5x15.6mm (APS-C) • FOCAL LENGTH MULTIPLIER 1.62x • VIEWFINDER Optical • LCD SCREEN 3in • OPTICAL ZOOM (35mm-EQUIVALENT FOCAL LENGTHS) 27-82.5mm (kit lens) • 35mm-EQUIVALENT APERTURE N/A • LENS MOUNT EF-mount • WEIGHT 755g (body only) • DIMENSIONS 104x139x79mm • WARRANTY One year RTB • DETAILS www.canon.co.uk • FULL REVIEW Nov 2013	

DISPLAYS

MONITOR	COMPUTER SHOPPER BEST BUY ★★★★★ BENQ GW2765HT £275 inc VAT • www.laptopsdirect.co.uk This 27in 2,560x1,440 IPS monitor is one of the best-value screens we've ever seen. With near-perfect sRGB colour accuracy out of the box, it's a steal for less than £300. SCREEN SIZE 27in • RESOLUTION 2,560x1,440 • SCREEN TECHNOLOGY IPS • VIDEO INPUTS VGA, DVI, HDMI, DisplayPort • WARRANTY Two years onsite • PART CODE G12765HT • DETAILS www.benq.co.uk • FULL REVIEW Jan 2015	
MONITOR	COMPUTER SHOPPER RECOMMENDED ★★★★★ VIEWSONIC VX2363Smhl-W £129 inc VAT • www.dabs.com The 23in VX2363Smhl-W stands out from the crowd with its white stand, IPS screen and great overall image quality. It's a good budget buy for those who have modest needs. SCREEN SIZE 23in • RESOLUTION 1,920x1,080 • SCREEN TECHNOLOGY IPS • VIDEO INPUTS VGA, DVI, HDMI, tx MHL-compatible HDMI • WARRANTY Two years collect and return • PART CODE VX2363Smhl-W • DETAILS www.viewsoniceurope.com • FULL REVIEW Jan 2015	
MONITOR	COMPUTER SHOPPER BEST BUY ★★★★★ IYYAMA ProLite GB2488HSU-B1 £208 inc VAT • www.scan.co.uk Gamers need look no further than the Iiyama ProLite GB2488HSU-B1. It's a no-nonsense Full HD panel with a 144Hz refresh rate for lightning-fast games. This display is great value. SCREEN SIZE 24in • RESOLUTION 1,920x1,080 • SCREEN TECHNOLOGY TN • VIDEO INPUTS 2x HDMI, DVI, DisplayPort • WARRANTY Two years onsite • PART CODE ProLite GB2488HSU-B1 • DETAILS www.iiyama.com • FULL REVIEW Aug 2014	
MONITOR	COMPUTER SHOPPER BEST BUY ★★★★★ ASUS PB279Q £598 inc VAT • www.ballicom.co.uk If you're remotely serious about design, photography or gaming and want an Ultra HD screen, this is the monitor to choose. It's plain to look at and has no USB hub, but in terms of pure image quality, nothing beats it at this price. SCREEN SIZE 27in • RESOLUTION 3,840x2,160 • SCREEN TECHNOLOGY AHVA • REFRESH RATE 60Hz • VIDEO INPUTS 4x HDMI, DisplayPort, Mini DisplayPort • WARRANTY Three years RTB • DETAILS www.asus.com • FULL REVIEW Apr 2015	
MONITOR	COMPUTER SHOPPER BEST BUY ★★★★★ SAMSUNG S32D850T £440 inc VAT • www.laptopsdirect.co.uk It's not cheap, but this 32in monitor is great value. Images are sharp and vibrant on its 2,560x1,440 panel, and the stand is among the most attractive we've seen. SCREEN SIZE 32in • RESOLUTION 2,560x1,440 • SCREEN TECHNOLOGY VA • VIDEO INPUTS HDMI, DVI, DisplayPort • WARRANTY Two years collect and return • PART CODE S32D850T • DETAILS www.samsung.com/uk • FULL REVIEW Jan 2015	

HOME CINEMA

COMPUTER SHOPPER LG 47LB730V

BEST BUY ★★★★★
£550 inc VAT • www.richersounds.co.uk

The LG 47LB730V has one of the best screens and smart TV interfaces we've seen. With its fantastic design and great picture quality straight out of the box, the 47LB730V is great value.

SCREEN SIZE 47in • NATIVE RESOLUTION 1,920x1,080 • VIDEO INPUTS 3x HDMI, SCART, component, composite • TUNER FreeviewHD • DIMENSIONS 1,061x666x227mm • WARRANTY Five years RTB • DETAILS www.lg.com/uk • PART CODE 47LB730V • FULL REVIEW Mar 2015



COMPUTER SHOPPER SAMSUNG UE40H5500

BEST BUY ★★★★★
£350 inc VAT • www.richersounds.co.uk

This is an excellent mid-range TV with brilliant 3D performance, great all-round picture quality and unparalleled online content. It's also available in models from 32in right up to 75in, making it the perfect fit for any room size.

SCREEN SIZE 40in • NATIVE RESOLUTION 1,920x1,080 • VIDEO INPUTS 3x HDMI, SCART, component, composite • TUNER Freeview HD • DIMENSIONS 906x578x96mm • WARRANTY Five years RTB • DETAILS www.samsung.com/uk • PART CODE UE40H5500 • FULL REVIEW May 2015



COMPUTER SHOPPER ONKYO TX-NR636

BEST BUY ★★★★★
£349 inc VAT • www.richersounds.co.uk

With multiple HDMI 2.0 ports for 4K content and Dolby Atmos Home support, the Onkyo TX-NR636 is an essential AV receiver if you're looking to futureproof your home cinema system.

HDMI INPUTS/OUTPUTS 7/2 • HDMI 2.0 INPUTS/OUTPUTS 5/1 • OUTPUT RESOLUTIONS 720p, 1080p, 4K • WIRELESS SUPPORT 802.11n, Bluetooth 2.1 • SPEAKER CONFIGURATION 7.2 • RMS POWER OUTPUT 1,120W • SIZE 435x173x329mm • WARRANTY Two years RTB • DETAILS www.eu.onkyo.com • PART CODE TX-NR636 • FULL REVIEW Jun 2015



COMPUTER SHOPPER SAMSUNG BD-H6500

BEST BUY ★★★★★
£99 inc VAT • www.very.co.uk

This 3D-capable Blu-ray player produces a great picture, offers an excellent range of Smart TV services and provides the best DVD upscaling we've seen at this price.

BLU-RAY PROFILE BD-Live (Profile 5) • HDMI VERSION 1.4 • 3D CAPABLE Yes • NETWORKING 1x 10/100, 802.11n • WARRANTY One year RTB • PART CODE BD-H6500 • DETAILS www.samsung.com/uk • FULL REVIEW Oct 2014



COMPUTER SHOPPER SAMSUNG HW-J7500

RECOMMENDED ★★★★★
£750 inc VAT • www.johnlewis.com

This curved 8.1 soundbar and wireless subwoofer not only looks great, but it also produces excellent sound and has plenty of ports.

SPEAKERS 8 • RMS POWER OUTPUT 320W • DIMENSIONS 1,230x170x42mm (soundbar), 291x371x291mm (subwoofer) • WEIGHT 4kg (soundbar), 7.8kg (subwoofer) • DOCK CONNECTOR None • NETWORKING Bluetooth 3.0 • WARRANTY One year RTB • DETAILS www.samsung.com/uk • PART CODE HW-J7500 • FULL REVIEW Jul 2015



AUDIO

COMPUTER SHOPPER PHILIPS Fidelio M2BT

BEST BUY ★★★★★
£184 inc VAT • www.amazon.co.uk

The Philips Fidelio M2BT are premium Bluetooth headphones that sound great, look fantastic and are supremely comfortable.

HEADPHONES TYPE On-ear Bluetooth • PLUG TYPE 3.5mm jack plug • WEIGHT 190g • CABLE LENGTH 1.2m • WARRANTY One year RTB • DETAILS www.philips.co.uk • PART CODE M2BTBK/00 • FULL REVIEW Apr 2015



COMPUTER SHOPPER BLUESOUND Pulse

RECOMMENDED ★★★★★
£599 inc VAT • www.sevenoakssoundandvision.co.uk

The audiophile's choice for multiroom audio. The Bluesound Pulse has excellent sound quality, support for high-resolution audio and is compatible with plenty of music-streaming services.

SPEAKERS 5 • RMS POWER OUTPUT 80W • DOCK CONNECTOR None • WIRELESS 802.11n Wi-Fi, 10/100 Ethernet, optional Bluetooth (SBC) • DIMENSIONS 420x190x197mm • WEIGHT 1.1kg • WARRANTY One year RTB • DETAILS www.bluesound.com • FULL REVIEW Mar 2015



COMPUTER SHOPPER FUGOO Fugoo

BEST BUY ★★★★★
From £144 inc VAT • www.amazon.co.uk

One of the most rugged speakers we've tested, thanks to its optional interchangeable jackets, and with six drivers it provides a fantastically loud, omnidirectional sound.

SPEAKERS 6 • WIRELESS Bluetooth (aptX) • DIMENSIONS Style: 165x66x54mm, Sport: 187x73x59mm, Tough: 197x73x59mm • WEIGHT Style: 442g, Sport: 519g, Tough: 624g • WARRANTY One year RTB • DETAILS www.fugoo.com • PART CODE Fugoo • FULL REVIEW Jul 2015



COMPUTER SHOPPER APPLE iPod Touch

BEST BUY ★★★★★
£199 inc VAT • store.apple.com/uk

The fifth iPod Touch is the best device of its kind. Its battery lasts for three days of continuous music playback or eight hours of video. Its display is great and its audio is as reliable as ever, though format support is limited.

CAPACITY (FORMATTED) 32GB • DISPLAY 4in colour LCD touchscreen • SUPPLIED HEADPHONES Earphones • SUPPORTED AUDIO FORMATS AAC, MP3, AIFF, WAV, Audible • WARRANTY One year RTB • PART CODE MD123B1/A • DETAILS www.apple.com/uk • FULL REVIEW Feb 2013



COMPUTER SHOPPER ARCAM miniBlink

RECOMMENDED ★★★★★
£100 inc VAT • www.petertyson.co.uk

Stream music from your mobile phone or tablet to your hi-fi with the petite and attractive miniBlink. This high-quality Bluetooth receiver sounds good and is delightfully simple to use.

WARRANTY Two years RTB • PART CODE miniBlink • DETAILS www.arcam.co.uk • FULL REVIEW Aug 2014



Choosing a ...

Soundbar

01 If you simply don't have room in your home cinema setup for a set of surround sound speakers, a soundbar is the next best thing. Whether you opt for a soundbar – which typically sits in front of your TV stand – or a soundplate, which sits underneath your TV, you'll be getting significantly better audio than the weedy speakers today's flatscreen TVs provide.

02 If you want to cut down on cable clutter, look for a soundbar with multiple HDMI inputs and outputs as well as Audio Return Channel (ARC). Not all soundbars use HDMI, with many making do with digital optical audio connections instead. This means you'll have to connect Blu-ray players, games consoles and set-top boxes to your TV and run all audio through a single cable. Also look for phono inputs for connecting older devices and 3.5mm audio jacks for tablets or smartphones.

03 As with any speaker, the number of speaker drivers inside a soundbar should give a good indication of its audio capabilities. Although this won't tell you everything about sound quality, you should still look out for separate mid-range drivers and tweeters, as these should be able to deliver a wider frequency range than full-range drivers alone.

04 Bluetooth support is a must if you want to listen to music from a smartphone or tablet without wires. Most soundbars now include Bluetooth as standard, but if your device supports it it's worth looking for a model that includes aptX. This less-lossy codec is capable of higher quality streaming than the standard A2DP profile. Airplay streaming is less common, but iPhone owners should keep an eye out for it.

05 For a little extra bass, be sure to look for a soundbar with a subwoofer. Many include a wired sub, but for extra convenience you should look for a model with a wireless subwoofer instead. These can be placed anywhere in a room with a power socket, without having to run a cable back to the soundbar itself.

Choosing an ...

Internal hard disk

01 A basic 1TB internal hard disk should cost around £40. It'll be fast enough for general use and provide enough storage for most users. Make sure the hard disk you choose has the appropriate interface type for your PC. Some mechanical hard disks still come with SATA2 interfaces, but newer models and most solid-state drives (SSDs) have faster SATA3 interfaces. You'll need a motherboard with a SATA3 port if you want to benefit from SATA3's faster speeds – SATA3 disks will work with SATA2 ports but can only transfer files at SATA2 speeds.

02 SSDs can make the most of SATA3's extra bandwidth for fast file transfers. They use flash memory similar to that found in USB flash drives, and although they tend to provide less capacity than mechanical hard disks, they're significantly faster.

03 Buy a hard disk that provides more capacity than you think you need, as your storage requirements are likely to grow. A 2TB disk strikes the best balance between capacity and low cost per gigabyte, but in general you should aim to buy the largest disk you can afford.

04 If you want more disk space or you want to protect your data against disk failure, think about buying several hard disks to create a RAID array. These use multiple hard disks to create one large logical disk with better performance, or to duplicate your data for better protection. RAID arrays require hard disks of the same size. In theory, they can be from different manufacturers, but it's better to buy identical disks if you can.

05 A hard disk's spindle speed determines how quickly it can transfer data. A spindle speed of 7,200rpm is common in desktop drives and is fast enough for most purposes. Desktop hard disks with 5,400rpm spindle speeds are quite slow but use less power and generate less heat and noise.

To strike the best balance between speed and storage capacity, use an SSD as your system disk and store your files on a larger mechanical disk.

STORAGE

SSD	COMPUTER SHOPPER RECOMMENDED ★★★★★ CRUCIAL MX100 256GB £97 inc VAT • uk.crucial.com The MX100 is quick for a budget SSD and the price makes the 256GB model fantastic value. 128GB and 512GB models are also available if you want to save money, or need more storage CAPACITY 256GB • COST PER GIGABYTE £0.39 • INTERFACE SATA3 • WARRANTY Three years RTB • PART CODE CT256MX100SSD1 • DETAILS uk.crucial.com • FULL REVIEW Apr 2015	
HARD DISK	COMPUTER SHOPPER BEST BUY ★★★★★ WESTERN DIGITAL Red 6TB £219 inc VAT • www.dabs.com The Red 6TB combines excellent performance with a high capacity and special firmware, making a hard disk that's perfect for use in NAS enclosures. CAPACITY 6TB • COST PER GIGABYTE £0.04 • INTERFACE SATA3 • WARRANTY Three years RTB • PART CODE WD60EFRX • DETAILS www.wdc.com • FULL REVIEW Nov 2014	
NAS	COMPUTER SHOPPER BEST BUY ★★★★★ SYNOLOGY Diskstation DS215j £144 inc VAT • www.ebuyer.com Synology's latest NAS is faster than its predecessor thanks to an upgraded CPU, and is capable of rapid file transfers. DSM is still the best NAS operating system we've used, too. 3.5in HARD DISK BAYS (FREE) 2 (2) • NETWORKING 2x 10/100/1,000 Ethernet • WARRANTY Two years RTB • PART CODE DS215j • DETAILS www.synology.com • FULL REVIEW Jun 2015	
PORTABLE SSD	COMPUTER SHOPPER BEST BUY ★★★★★ SAMSUNG T1 500GB £203 inc VAT • www.scan.co.uk The T1 is significantly faster than any USB3 flash drive as it has its own SD controller. Combined with a USB3 connection, it's able to transfer files at unbelievable speeds – then slips into a pocket for taking on the move. CAPACITY 500GB • COST PER GIGABYTE £0.41 • INTERFACE USB3 • CLAIMED READ 450MB/s • CLAIMED WRITE 450MB/s • WARRANTY Three years RTB • PART CODE MU-PS500B/EU • DETAILS www.samsung.com/uk • FULL REVIEW Apr 2015	
PORTABLE HARD DISK	COMPUTER SHOPPER BEST BUY ★★★★★ WESTERN DIGITAL My Passport Ultra 1TB £60 inc VAT • www.pcworld.co.uk This compact 5,400rpm USB3 external hard disk comes with excellent backup and encryption software. We reviewed the 1TB model, which is a bargain, but for an extra £25 you can pick up the 2TB version. CAPACITY 1TB • COST PER GIGABYTE £0.06 • SPINDLE SPEED 5,400rpm • INTERFACES USB3 • DIMENSIONS 15x82x11mm • WARRANTY Three years RTB • PART CODE WDBZFP0010BKK • DETAILS www.wdc.com • FULL REVIEW Sep 2013	

PRINTERS AND SCANNERS

MONO LASER PRINTER	COMPUTER SHOPPER BUSINESS BUY ★★★★★ XEROX Phaser 3610 £335 inc VAT • www.printerland.co.uk The Phaser 3610 is a mono laser printer for small firms and workgroups. It's fast, reaching 47ppm in our tests, and has a claimed monthly duty cycle of up to 110,000 pages. Best of all, at 1.1p per page it's cheap to run. TECHNOLOGY Mono laser • MAXIMUM PRINT RESOLUTION 1,200x1,200dpi • DIMENSIONS 315x395x426mm • WEIGHT 13kg • MAXIMUM PAPER SIZE A4/legal • WARRANTY One year onsite • PART CODE 3610V_DN • DETAILS www.xerox.co.uk • FULL REVIEW Jan 2014	
COLOUR LASER	COMPUTER SHOPPER BEST BUY ★★★★★ CANON i-SENSYS LBP7780Cx £414 inc VAT • www.lambda-tek.com It's somewhat expensive to buy, but the Canon i-SENSYS LBP7780Cx is very cheap to run and produces impressively high-quality prints. TECHNOLOGY Single-pass colour laser • MAXIMUM PRINT RESOLUTION 600x600dpi • DIMENSIONS 401x517x530mm • WEIGHT 31kg • MAXIMUM PAPER SIZE A4/legal • WARRANTY One year onsite • DETAILS www.canon.co.uk • PART CODE 6140B010AA • FULL REVIEW Mar 2015	
INKJET MFP	COMPUTER SHOPPER BEST BUY ★★★★★ EPSON Expression Photo XP-760 £130 inc VAT • www.box.co.uk It's not brilliant for printing office documents, but if you want great photos and brilliant scanning, Epson's good-looking and compact XP-760 is perfect. TECHNOLOGY Piezo inkjet • MAXIMUM PRINT RESOLUTION 5,760x1,440dpi • MAXIMUM OPTICAL SCAN RESOLUTION (OUTPUT BIT DEPTH) 2,400x4,800dpi (48-bit) • DIMENSIONS 141x290x341mm • WEIGHT 6.9kg • MAXIMUM PAPER SIZE A4/legal • WARRANTY One year RTB • DETAILS www.epson.co.uk • PART CODE C11CD96401 • FULL REVIEW Mar 2015	
INKJET MFP	COMPUTER SHOPPER BEST BUY ★★★★★ CANON Pixma MG5650 £71 inc VAT • www.printerland.co.uk This multifunction peripheral provides duplex printing and Wi-Fi, as well as good-quality scans, prints and copies, and at 7.3p per page its running costs are fairly low. It's an excellent general-purpose MFP. TECHNOLOGY Thermal inkjet • MAXIMUM PRINT RESOLUTION 4,800x1,200dpi • SCANNER RESOLUTION 1,200x1,200dpi • DIMENSIONS 148x455x369mm • WEIGHT 6.3kg • MAXIMUM PAPER SIZE A4/legal • WARRANTY One year RTB • PART CODE 9487B008AA • DETAILS www.canon.co.uk • FULL REVIEW Dec 2014	
OFFICE PRINTER	COMPUTER SHOPPER BEST BUY ★★★★★ HP Officejet Pro X476dw £340 inc VAT • www.ebuyer.com It may be an inkjet, but HP's MFP beats many colour lasers in terms of speed, print quality and running costs. TECHNOLOGY Thermal inkjet • MAXIMUM PRINT RESOLUTION 2,400x1,200dpi • SCANNER RESOLUTION 1,200x1,200dpi • DIMENSIONS 517x517x399mm • WEIGHT 24kg • MAXIMUM PAPER SIZE A4/legal • WARRANTY One year onsite • DETAILS www.hp.co.uk • PART CODE CN461A • FULL REVIEW Mar 2015	

NETWORKS

PORTABLE 3G ROUTER

COMPUTER SHOPPER
RECOMMENDED

TP-LINK M5350

£40 inc VAT • www.amazon.co.uk

The M5350 is a bargain portable 3G router that's easy to set up and use. Its screen could be bigger, but the icons are clearly displayed. It's great for making the most of your data SIM.

MODEM 3G • WI-FI STANDARD 802.11n • USB PORTS None • WALL MOUNTABLE? No • WARRANTY Three years RTB • PART CODE M5350 • DETAILS uk.tp-link.com • FULL REVIEW Dec 2014



MODEM ROUTER

COMPUTER SHOPPER
BEST BUY

ASUS DSL-AC68U

£155 inc VAT • www.pcworl.co.uk

The DSL-AC68U combines high-speed performance with the ability to use a 3G or 4G modem, operate as a NAS and share a USB printer.

MODEM ADSL2+/VDSL2 • WI-FI STANDARD 802.11ac • STATED SPEED 1,300Mbit/s • USB PORTS 1x USB3 • WARRANTY Three years RTB • PART CODE DSL-AC68U • DETAILS www.asus.com • FULL REVIEW Jan 2015



WI-FI RANGE EXTENDER

COMPUTER SHOPPER
RECOMMENDED

NETGEAR AC750-Wi-Fi Range Extender

£52 inc VAT • www.dabs.com

This Wi-Fi extender helps liven up the Wi-Fi deadzones in your home or office. It works on both the 2.4GHz and 5GHz bands simultaneously, and it even has an Ethernet port that's ideal for connecting devices such as games consoles and smart TVs.

WARRANTY Two years RTB • DETAILS www.netgear.co.uk • PART CODE EX6100-100UKS • FULL REVIEW Nov 2014



POWERLINE KIT

COMPUTER SHOPPER
RECOMMENDED

DEVELO dLAN 1200+ Starter Kit

£120 inc VAT • www.dabs.com

Devol's dLAN 1200+ is the fastest Powerline networking kit we've seen, even if you're limited to a single Gigabit Ethernet connection. The passthrough sockets are very convenient too.

POWERLINE NETWORKING STANDARD HomePlug • STATED SPEED 1,200Mbit/s • ADAPTORS IN BOX 2 • WARRANTY Three years RTB • PART CODE 09378 • DETAILS www.devol.com/uk • PART CODE 09378 • FULL REVIEW Feb 2015



WIRELESS ROUTER

COMPUTER SHOPPER
BEST BUY

LINKSYS WRT1900AC

£200 inc VAT • www.currys.co.uk

The WRT1900AC's Wi-Fi performance is superb whether you're using 802.11ac or 802.11n equipment, and its many features make it a must-buy for those who like to tinker.

MODEM None • WI-FI STANDARD 802.11ac • STATED SPEED 1,300Mbit/s • USB PORTS 2 • WALL MOUNTABLE Yes • WARRANTY Two years RTB • PART CODE WRT1900AC • DETAILS www.linksys.com • FULL REVIEW Aug 2014



VIDEO

SMART TV ADAPTOR

COMPUTER SHOPPER
RECOMMENDED

AMAZON Fire TV

£79 inc VAT • www.amazon.co.uk

Fire TV provides access to Amazon's Instant Video service, as well as on-demand services such as BBC iPlayer. You also get access to apps and games from Amazon's App Store, which can take advantage of the optional Amazon Fire TV game controller, making the Fire TV a simple games console.

VIDEO OUTPUTS HDMI • NETWORKING 802.11n (dual band) • DIMENSIONS 78x28x12mm • STREAMING FORMATS UPnP, AirPlay, DLNA • INTERNET STREAMING SERVICES iPlayer, Netflix, Sky News, Spotify, TuneIn Radio, Amazon Instant Video, TVPlayer • WARRANTY One year RTB • PART CODE Fire TV • DETAILS www.amazon.co.uk • FULL REVIEW Dec 2014



ACTION CAM

COMPUTER SHOPPER
RECOMMENDED

GOPRO Hero4 Black

£300 inc VAT • www.amazon.co.uk

The GoPro Hero4 Black doesn't deviate from the existing GoPro template but is an excellent action camera that introduces stunning 4K video at 30fps. You also get support for a wide range of mounts and accessories, meaning you'll be able to capture fantastic footage whatever the activity.

SENSOR 1/2.3in CMOS • SENSOR PIXELS 12,000,000 • MAX RECORDING RESOLUTION 4K (30fps) • AV CONNECTIONS Micro HDMI output, 3.5mm microphone to Mini USB (optional) • DIMENSIONS 41x59x30mm • WEIGHT 89g (152g with housing) • WARRANTY One year RTB • DETAILS www.gopro.com • PART CODE CHDHX-4-1-EU • FULL REVIEW May 2015



CAMCORDER

COMPUTER SHOPPER
BEST BUY

CANON Legria HF G30

£883 inc VAT • www.nigelohara.com

This fantastic enthusiast camcorder has a capacitive touchscreen monitor, a great electronic viewfinder and a sensible array of function buttons. Its image quality is excellent, too.

OPTICAL ZOOM 20x • SENSOR 1/2.3in CMOS • LCD SCREEN 3.7in LCD, 1,230,000 dots • DIMENSIONS 84x189x182mm • WEIGHT 900g • WARRANTY One year RTB • PART CODE 84548009AA • DETAILS www.canon.co.uk • FULL REVIEW Sep 2013



GAMEPLAY RECORDER

COMPUTER SHOPPER
RECOMMENDED

HAUPPAUGE HD PVR Rocket

£112 inc VAT • www.ebuyer.com

The HD PVR Rocket lets you record your gameplay from a PC or games console, including your own commentary. It's well designed, with a large red Record button and the ability to record directly to a USB drive.

WARRANTY Two years RTB • PART CODE 1527 • DETAILS www.hauppage.co.uk • FULL REVIEW Apr 2013



CAMCORDER

COMPUTER SHOPPER
BEST BUY

PANASONIC HC-X920

£679 inc VAT • www.wexphotographic.com

This camcorder uses three 1/2.3in BSI MOS sensors to record Full HD video with excellent colour reproduction and tremendous detail. Its built-in Wi-Fi adaptor lets you connect to a smartphone or stream video over your network.

OPTICAL ZOOM 12x • SENSOR 3x 1/2.3in BSI MOS • LCD SCREEN 3.7in LCD, 1,152,000 dots • DIMENSIONS 72x67x50mm • WEIGHT 417g • WARRANTY One year RTB • PART CODE HC-X920EB-K • DETAILS www.panasonic.co.uk • FULL REVIEW May 2013



Choosing a ...

Camcorder

01 If you want to shoot simple home movies, buy a basic flash memory camcorder. This should cost around £140 and will produce decent results in most lighting conditions. Check the battery life, which should preferably provide enough power for at least 90 minutes of recording.

02 Most camcorders are described as HD, but that's no guarantee of good image quality. Ignore the number of pixels the sensor has and concentrate on the size of the sensor itself. The smallest sensors are usually 1/4in, and sizes increase in fractions to around 1/2in. A larger sensor gives you higher video quality and enables you to capture better footage in poor lighting conditions. An alternative technology often found in Panasonic camcorders uses three small sensors instead of one large one to produce excellent image quality.

03 Most camcorders rely on flash memory or memory cards to store your video. Many manufacturers make a range of near-identical models, although the more expensive devices have additional flash memory built in. Generally speaking, it's cheaper to buy the card-only version of the camera and a couple of 16GB memory cards than to invest in a model that has built-in flash memory. DVD and hard disk camcorders are out of date and will probably be discontinued models. Avoid them.

04 If you're planning to shoot something more than just a family holiday, you'll want extra features. A good manual focus control allows for more flexible camerawork, while an accessory shoe and microphone input lets you use an external microphone, improving audio quality greatly.

05 If you're really serious about film-making then buying a few additional accessories will make all the difference to the results. A tripod will improve your footage more than splashing out on a big sensor would. Spare batteries are essential for longer shoots, and some decent video-editing software will help you to produce a more polished result.

Choosing a ... Graphics card

01 You really don't have to spend much to buy a decent graphics card that can drive multiple monitors. The AMD Radeon R7 250 costs less than £60, for example, and while it isn't suited to playing the latest games in Full HD, it is perfect for watching videos, browsing the web and playing basic games.

02 You'll need to spend more money if you want to play games, though. A good mid-range gaming graphics card is the AMD R9 270X, which is powerful enough to play any of the latest games. High-powered cards tend to be more expensive, so expect to pay over £300 if you want to play games in Ultra HD at the highest quality settings.

03 Check that your chosen card has the graphics outputs you need. Only low-end cards now have VGA outputs, but many come with a DVI-to-VGA adaptor. Depending on your monitor, you may also want an HDMI output or even DisplayPort. Bear in mind that AMD's Eyefinity triple-monitor gaming mode requires at least one DisplayPort monitor, which means your AMD graphics card must have at least one DisplayPort output. Nvidia's Surround three-monitor mode needs only DVI and HDMI ports.

04 The amount of memory a card has is important if you want games to look their best at high resolutions. Get a card with 2GB of RAM at the very least, as this should allow you to select the highest-quality textures in games.






05 A card's size, noise output and power requirements are the final considerations. Make sure your PC's case has enough room to accommodate your chosen card. Double-slot cards with large fans tend to be quieter than single-slot cards with small fans but will block other expansion slots on your motherboard.

Also check that your power supply can provide the power the card needs and that it has the right connectors. Many cards require a six-pin PCI Express power connector, and some also need an additional eight-pin connector.

COMPONENTS

GRAPHICS CARD	COMPUTER SHOPPER RECOMMENDED	XXXX	XFx Radeon R9 290 Black Double Dissipation Edition	
	E232 inc VAT • www.scan.co.uk The R9 290 does most of what the top-end R9 290X can do but at a lower price, and neatly undercuts Nvidia's GeForce GTX 970, making it the obvious choice for 1440p gaming. GPU AMD Radeon R9 290 • MEMORY 4GB GDDR5 • CARD LENGTH 283mm • WARRANTY Two years RTB • DETAILS www.xfxforce.com • PART CODE R9-290A-EDBD • FULL REVIEW May 2015			
PROCESSOR	COMPUTER SHOPPER BEST BUY	XXXX	INTEL Core i5-4690K	
	£187 inc VAT • www.scan.co.uk The Core i5-4690K is a redesigned variant of the Core i5-4670K and runs at a faster speed out of the box but at lower temperatures. Coupled with its unlocked multiplier, this means the chip is ideal for overclocking. SOCKET LGA1150 • CORES 4 • FREQUENCY 3.5GHz • INTEGRATED GRAPHICS Intel HD Graphics 4600 • WARRANTY One year RTB • DETAILS www.intel.com • PART CODE BX80646I54690K • FULL REVIEW May 2015			
PROCESSOR	COMPUTER SHOPPER BEST BUY	XXXX	AMD A10-7700K	
	£90 inc VAT • www.scan.co.uk The A10-7700K is strikes an excellent balance between desktop and graphics performance, making it the ideal all-rounder for an inexpensive PC build. SOCKET FM2 • CORES 4 • FREQUENCY 3.4GHz • INTEGRATED GRAPHICS AMD Radeon R7 • WARRANTY One year RTB • DETAILS www.amd.com • PART CODE AD770KXBJABOX • FULL REVIEW May 2015			
MOTHERBOARD	COMPUTER SHOPPER RECOMMENDED	XXXX	ASUS Z97-E	
	£99 inc VAT • www.dabs.com The Asus Z97-E is well priced for an LGA1150 motherboard, and automatic overclocking helps squeeze extra performance from your CPU with minimal effort. SOCKET LGA1150 • CHIPSET Intel Z97 • MEMORY SLOTS 4 • PCI-E x16 SLOTS 2 • PCI-E x1 SLOTS 3 • PCI SLOTS 2 • USB PORTS 2x USB, 4x USB3 • VIDEO OUTPUTS HDMI, DVI, VGA • DIMENSIONS 305x218mm • WARRANTY Three years RTB • DETAILS www.asus.com • PART CODE Z97-E • FULL REVIEW May 2015			
PC CASE	COMPUTER SHOPPER RECOMMENDED	XXXX	SILVERSTONE Quiet Precision PS11	
	£37 inc VAT • www.scan.co.uk Well made and finished for the price, with plenty of sound-deadening features, the PS11 is the ideal starting point for a new PC build. The design might be a little plain, but we aren't complaining for £35. CASE TYPE ATX • MOTHERBOARD COMPATIBILITY ATX, microATX, Mini-ITX • SUPPLIED FANS 1x 120mm • MAX 3 1/2in DRIVE BAYS 3 • MAX 5 1/2in DRIVE BAYS 2 • DIMENSIONS 215x482x427mm • WEIGHT 4.8kg • WARRANTY One year RTB • DETAILS www.silverstonetek.com • PART CODE SST-PS11B-Q • FULL REVIEW May 2015			

SOFTWARE

VIDEO EDITING	COMPUTER SHOPPER BEST BUY	XXXX	ADOBE Premiere Elements 13	
	£79 inc VAT • www.adobe.com/uk Premiere Elements 13 offers a wealth of features to keep advanced video editors happy and has even more to help new users make the most of it. It's the best consumer video-editing package you can buy. OS SUPPORT Windows 7, 8 • MINIMUM CPU 2GHz with SSE2 • MINIMUM GPU DirectX 9 or 10 • MINIMUM RAM 2GB • HARD DISK SPACE 5GB • DETAILS www.adobe.com/uk • PRODUCT CODE 65234288 • FULL REVIEW Jan 2015			
DESKTOP PUBLISHING	COMPUTER SHOPPER BEST BUY	XXXX	SERIF PagePlus X8	
	£90 inc VAT • www.serif.com Get full control over the layout and appearance of your documents, from flyers to professional-looking publications. Version 8 adds a baseline grid, making text easier to line up, and improves photo editing. OS SUPPORT Windows XP or later • MINIMUM CPU Intel Pentium 4 or later, AMD Athlon 64 or later • MINIMUM GPU Not stated • MINIMUM RAM 512MB (Windows XP), 1GB (Vista, 32-bit Windows 7/8), 2GB (64-bit Windows 7/8) • HARD DISK SPACE 510MB • DETAILS www.serif.com/pageplus • PRODUCT CODE N/A • FULL REVIEW Feb 2015			
PHOTO EDITING	COMPUTER SHOPPER RECOMMENDED	XXXX	ADOBE Photoshop Elements 13	
	£79 inc VAT • www.adobe.com/uk Elements may not have all the features of the full version of Photoshop, but it's still our favourite photo-editing package, and version 13 is the best yet, thanks to a new Guided mode for newcomers. OS SUPPORT Windows 7, 8 • MINIMUM CPU 1.6GHz with SSE2 • MINIMUM GPU DirectX 9 or 10 • MINIMUM RAM 2GB • HARD DISK SPACE 5GB • DETAILS www.adobe.com/uk • PRODUCT CODE 65237742 • FULL REVIEW Feb 2015			
GRAPHIC DESIGN	COMPUTER SHOPPER BEST BUY	XXXX	SERIF Affinity Designer	
	£40 inc VAT • affinity.serif.com/en-gb The first real competition to Adobe's Illustrator may be an OS X exclusive, but Affinity Designer is a seriously powerful graphic design tool that costs an incredibly reasonable £40. OS SUPPORT Apple OS X 10.7.5 • MINIMUM CPU Core 2 Duo (64-bit) • MINIMUM GPU Intel HD Graphics • MINIMUM RAM 1GB • HARD DISK SPACE 525MB • DETAILS affinity.serif.com • PRODUCT CODE Affinity Designer • FULL REVIEW Mar 2015			
MUSIC PRODUCTION	COMPUTER SHOPPER BEST BUY	XXXX	STEINBERG Cubase Artist 8	
	£220 inc VAT • www.steinberg.net Music production software usually saves the best features for the priciest version, but that's not the case here, making Cubase Artist 8 an excellent investment for musicians aspiring to the highest standards. OS SUPPORT Windows 7 or later • MINIMUM CPU Intel Core iA dual-core • MINIMUM GPU DirectX 10 • MINIMUM RAM 4GB • HARD DISK SPACE 15GB • DETAILS www.steinberg.net • PRODUCT CODE 45550 • FULL REVIEW May 2015			



MAGBOOK

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How we test

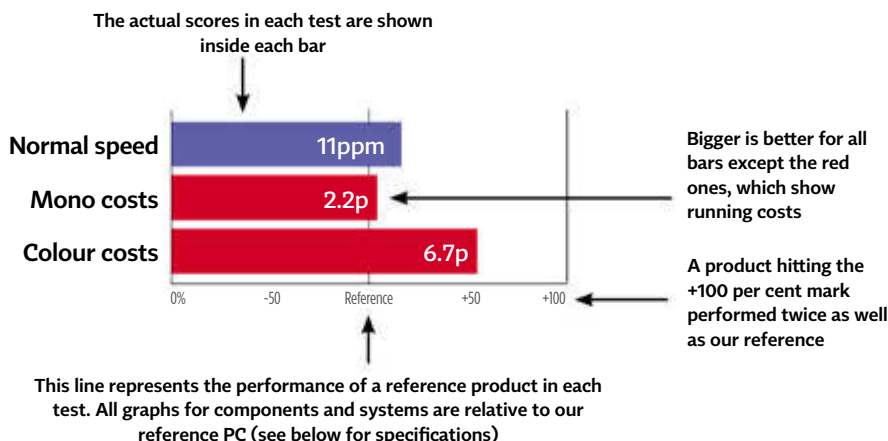
Find out how well products perform with the help of *Computer Shopper's* comprehensive tests

COMPUTER SHOPPER'S REVIEWS use some of the most exhaustive testing procedures you'll find in any PC magazine. Every product is subjected to qualitative and quantitative tests that show how it performs in practical use. Graphs for performance, battery-life scores and costs are used in the Reviews section, as shown on the right. Look in the 'Summary of tests' box (below) for details of each test we run.

For PCs and laptops, we evaluate performance using our own custom benchmarking suite. See below for a brief description of our benchmarking software and game tests.

SUMMARY OF TESTS

PC SYSTEMS	
Windows overall	Average speed across numerous demanding tasks
Multitasking	Speed when running simultaneous applications
Dirt Showdown (1080p)	Frames per second at 1,920x1,080, 4xAAA, Ultra detail
Metro: Last Light Redux	Frames per second at 1,920x1,080, SSAA, Very High detail
LAPTOPS	
Windows overall	Average speed across numerous demanding tasks
Multitasking	Processor-intensive multitasking test
Dirt Showdown (720p)	Frames per second at 1,280x720, 4xAAA, High detail
Battery life	Run time in minutes for continuous video playback
SMARTPHONES/TABLETS	
Battery life	Run time in minutes for continuous video playback
PRINTERS AND MFPs	
Normal speed	Pages per minute for correspondence-quality text
Mixed colour speed	Pages per minute for presentable text and graphics
Mono costs	Running costs expressed as pence per page
Colour costs	Running costs expressed as pence per page
DIGITAL CAMERAS	
Battery life	Number of shots from full charge
CAMCORDERS	
Battery life	Run time in minutes for recording
MP3 PLAYERS	
Battery life	Run time in minutes for continuous playback
ROUTERS	
Laptop 24GHz 10m	Mbit/s at 10m with laptop on 24-GHz band
Laptop 24GHz 25m	Mbit/s at 25m with laptop on 24-GHz band
Laptop 5GHz 10m	Mbit/s at 10m with laptop on 5GHz band
Laptop 5GHz 25m	Mbit/s at 25m with laptop on 5GHz band
Wi-Fi adaptor 10m	Mbit/s at 10m with a Wi-Fi adaptor
Wi-Fi adaptor 25m	Mbit/s at 25m with a Wi-Fi adaptor
NETWORK-ATTACHED STORAGE	
Large files	Average MB/s for read/write of 100MB large files
Small files	Average MB/s for read/write of 100MB small files
HARD DISKS	
Extra large files	Average MB/s for read/write of a 6GB file
Large files	Average MB/s for read/write of 100MB large files
Small files	Average MB/s for read/write of 100MB small files
PROCESSORS	
Windows overall	Average speed across numerous demanding tasks
Multitasking	Speed when running simultaneous applications
Dirt Showdown (720p)	Frames per second at 1,280x720, 4xAAA, High detail
MOTHERBOARDS	
Windows overall	Average speed across numerous demanding tasks
Multitasking	Speed when running simultaneous applications
Dirt Showdown (1080p)	Frames per second at 1,920x1,080, 4xAAA, Ultra detail
Dirt Showdown (720p)	Frames per second at 1,280x720, 4xAAA, High detail
GRAPHICS CARDS	
Dirt Showdown (1080p)	Frames per second at 1,920x1,080, 4xAAA, Ultra detail
Tomb Raider	Frames per second at 1,920x1,080, SSAA, Ultra detail
Metro: Last Light Redux	Frames per second at 1,920x1,080, SSAA, Very High detail



BENCHMARKS

SHOPPER BENCHMARKS

Our benchmark suite uses open-source software that runs on Windows, Mac OS X and Linux systems. This lets us use objective results to compare PCs and laptops, no matter which operating system they run. It's designed to test each computer to its limit, using a combination of intensive image-editing, video-encoding and multitasking tests.

We ran the tests on our reference PC, which has an Intel Core i5-4670K processor, 8GB of DDR3 RAM and an AMD Radeon R7 260X graphics card. We normalised our results so this PC had a score of 100. This makes it easy to draw comparisons between test systems.

The resulting overall score is shown at the bottom of every PC and laptop review. As we use the same tests in our standalone and group test reviews, you can compare the performance of any computer, whether it's a netbook, laptop or desktop, from both sections of the magazine.

To see how your computer compares, you can download the suite from www.shopperdownload.co.uk/benchmarks. Versions are available for 32-bit and 64-bit operating systems.

3D BENCHMARKS

DIRT SHOWDOWN

Dirt Showdown is a cracking racing game that makes good use of DirectX 11's fancy graphical effects. You'll want at least 30fps for smooth racing.



TOMB RAIDER

With the ultra-demanding Super-Sampling Anti-Aliasing (SSAA) enabled, 2013's Tomb Raider reboot is a great indicator of mid-range performance.



METRO: LAST LIGHT REDUX

Our most demanding graphics test uses tessellation, SSAA and massive textures to give even high-end cards a thorough workout.



RATINGS & AWARDS

Computer Shopper rates products out of five:

Avoid	☆☆☆☆☆
Below average	☆☆☆☆☆
Good	☆☆☆☆☆
Very good	☆☆☆☆☆
Excellent	☆☆☆☆☆

The best products can win the following awards:

BEST BUY

Products with outstanding quality and performance for the money win our Best Buy award.



RECOMMENDED

Products that don't quite qualify for a Best Buy award but are still highly rated by our reviewers.



BUSINESS

The very best products for work win our Business Buy award.



Product Reviews

Our guide to all the products reviewed in this month's *Shopper*

112
Reviews

Lead Product 24

Apple MacBook

PCs & Laptops 26

Acer Revo One RL85

Asus X555LA

Palicomp Intel i7 Elite

Scan 3XS Graphite LG157

Handhelds 32

HTC Desire 820

LG G4

Microsoft Lumia

640/640 XL

Tablets Group Test 78

Acer Iconia One 7 B1-750

Apple iPad Air 2

Apple iPad Mini 3

Asus MeMO Pad 7 ME572C

Asus Transformer Book

T100 Chi

Dell Venue 8 7840

Google Nexus 9

Microsoft Surface 3

Samsung Galaxy Tab S 8.4

Samsung Galaxy Tab S 10.5

Sony Xperia Z3 Tablet

Compact

Sony Xperia Z4 Tablet

Tesco Hudl 2

Vodafone Tab prime 6

Photography 36

Fujifilm XQ2

Nikon D7200

Panasonic Lumix DMC-GF7

Displays 39

BenQ RL2755HM

ViewSonic PJD6352

Home Cinema 42

Crystal Acoustics Teevy 6

LG 60UF850V

Polk MagniFi

Audio 47

Creative Sound Blaster E5

Ultimate Ears UE Megaboom

Video 48

Amazon Fire TV Stick

Rollei Actioncam 400

Printers & Scanners 52

Brother DCP-J4120DW

Canon Pixma MG6650

Epson Expression Home

XP-422

HP Officejet 5740

Networks 54

TP Link RE210 AC750 Wi-Fi

Range Extender

BT 11ac Dual-band Wi-Fi

Extender 1200

Storage 56

HGST Deskstar NAS 6TB

Components 56

Pipsta

Zotac Zbox Nano CI321

Software 59

Adobe Photoshop

Lightroom 6

Games 60

Project CARS

The Witcher 3: Wild Hunt

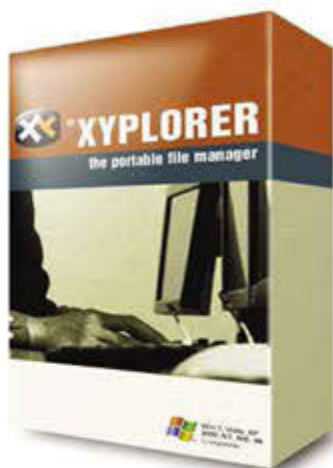
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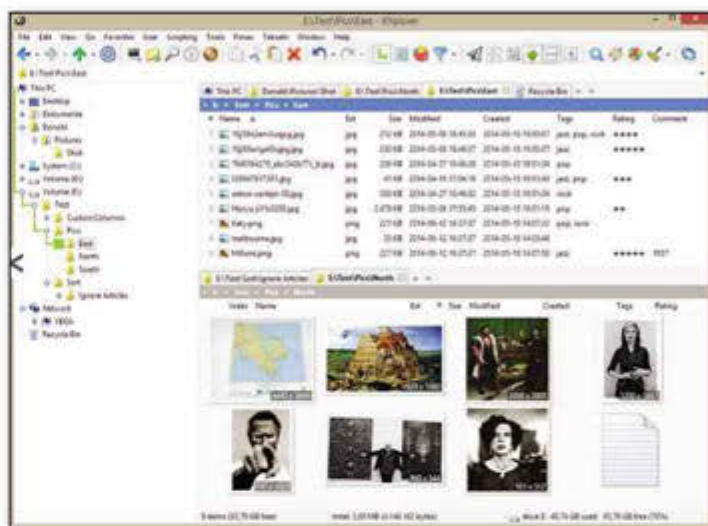


XYplorer 15

ONE OF THE limitations of Windows Explorer is its inability to display the contents of more than one folder at a time. While it is possible to open multiple windows to get around this problem, this is something of an inelegant solution and goes some way to explaining the wide range of Explorer replacement tools that are available.

Explorer replacements tend to fall into one of two categories: those that offer dual-pane views for working with two or more folders simultaneously, and those that have tabbed interfaces to make it easier to switch between multiple locations. XYplorer offers the best of both worlds, providing both tabs and dual-pane options.

The program has advanced options for working with files, including an undo facility and the ability to queue up a number of file operations for efficient, sequential execution. A unique mini-tree view makes it easy to access your most frequently used folders, while recently used locations can be accessed via hotkeys.



XYplorer reveals a wealth of information about selected drives, folders and files, and enables files to be previewed with a single click. Files can be categorised and organised using tags, colours, comments and labels and an advanced filtering system is available to make it easy to find a particular file or type of file.

XYplorer is undoubtedly one of the most comprehensive Explorer replacement tools available, and is open to a high level of customisation to make sure it works the way you want it to.

GETTING STARTED

The download instructions on the opposite page show you how to connect to the download site. Please make sure that you type in the web address exactly as shown. You'll need your coupon code the first time you log on.

ANY PROBLEMS

If you need help with any of the software this month, please send an email to letters@computershopper.co.uk. We check this inbox regularly. Please include the issue number of the magazine and your coupon code.

WHY DOWNLOADS

Software manufacturers have been requiring us to use online registration for some time now, but increasingly we're being asked to provide the program as a download. In order to continue bringing you the best free software, we've revamped our download site. You need to use the unique code printed in the box on the facing page to register and download the software in this issue.

The unique code means we stop the deals leaking online, so only Shopper readers get the software. You'll also enjoy a smoother registration, where we handle the registration process.

NO CODE?

If you don't have the card insert with the unique code, you must buy the £4.99 print version of the magazine. If you have bought this, please contact letters@computershopper.co.uk for help and a new code.

REQUIREMENTS Windows XP, Vista, 7 or 8 32/64-bit, 40MB hard disk space
WEBSITE xyplorer.com
NOTES No registration code required



Icecream PDF Split & Merge Pro

ICECREAM PDF SPLIT & Merge is a tool for splitting PDFs into multiple pages, merging PDFs into a single document, or simply removing pages you don't need.

The Split module can only handle one file at a time, but you do get plenty of control, with options to split your file into single pages, groups (sets of x consecutive pages starting from page y) and ranges (any specified range, such as 3-9 or 12-14), while you're also able to delete any page numbers you specify.

You can then select the destination for your split or merged files, with options to save your split files into a subfolder, the source folder, or some other folder of your choice.

Click Split when you're done and the program splits your source file almost instantly, then offers to open the folder for you to view the results.

The Merge module is more straightforward: drag and drop your source files, rearrange them into the preferred order, choose a destination folder and merge them with a click. Both the Split and Merge functions will also work with encrypted files, as long as you know and enter the password.

REQUIREMENTS Windows XP, Vista, 7 or 8 32/64-bit, 50MB hard disk space
WEBSITE icecreamapps.com
NOTES Get your registration code at pdfsplit.disc.computershopper.co.uk

Chat and Communication

Digsby (Build 92) Access all your instant messaging services from one application; there's support for Windows Live!, Yahoo!, AIM, Google Talk, ICQ and Jabber.

UPDATED Evernote 5.8.6 Store your notes, ideas and plans in the cloud, and synchronise them between computers.

UPDATED Mozilla Thunderbird 31.7 A powerful email client from the organisation best known for the Firefox web browser.

Postbox Express 1.0.1 An email client that provides a comprehensive array of tools to help you manage your messages more easily.

UPDATED Skype for Windows 7.4 Make internet voice and video calls for free, and buy credit to make calls to mobiles and landlines.

Trillian 5.5.0.19 Use all your instant messaging accounts with one application; this program has support for Windows Live!, AIM, Yahoo! and Google Talk.



Customisation

7 Taskbar Tweaker 4.5 Customise the Windows 7 taskbar so that it works exactly to your liking.

Metro UI Tweaker for Windows 8

Tweak the new user interface for Windows 8.

Mosaic Desktop Beta 1 Refresh Add Windows 8's mosaic-tiled desktop to your computer without having to upgrade.

UPDATED Rainmeter 3.2.1 Customise the desktop quickly and easily with your choice of information, tools and shortcuts.

Windows 8 Transformation Pack 9.1

Emulate the look of Windows 8 on an earlier version of the operating system.

UPDATED Windows 10 Transformation

Pack 3 Bring some of Windows 10's new features to your current operating system.



General

Free Studio 6.5 This software provides an easy way to convert your video and audio files into different formats.

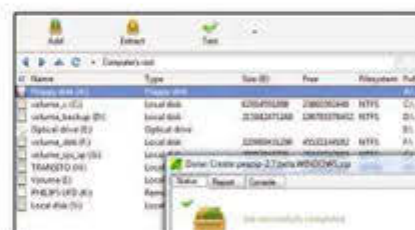
Paragon Partition Manager 2014 Free Create, format, split, merge and reorganise all your hard disk's partitions.

PeaZip 5.6 A tremendously powerful archive-management tool.

UPDATED Screenshot Captor 4.10 Create and manage screenshots the easy way.

SUMo 3.13 Quickly scan your PC's installed applications and find any updates available for them.

ZipGenius 6.3.2 A flexible file-compression tool with support for a huge number of compressed file formats.



Internet and Network

UPDATED CarotDAV 1.12

Manage all your online storage services with one simple application.

UPDATED Cyberduck 4.7

A powerful but easy-to-use FTP client for uploading and downloading your files.

Easy WiFi 4.01

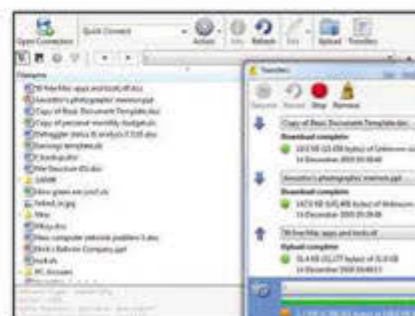
Find free Wi-Fi hotspots while you're out and about.

NetBalancer 8.6.2 Make the most of your internet connection by assigning download and upload priorities to web applications.

TeamViewer 10.0

Remote-control your computer from anywhere in the world.

Vuze 5.6 A BitTorrent client to help you locate, share and download torrent files.



Tweaking and Performance

UPDATED CCleaner 5.0.5 Remove unwanted information, temporary files, browsing history, huge log files and even the settings that uninstalled software leaves behind.

Defraggler 2.18 Ensure that your system is defragmented properly and improve its performance with this useful defrag tool.

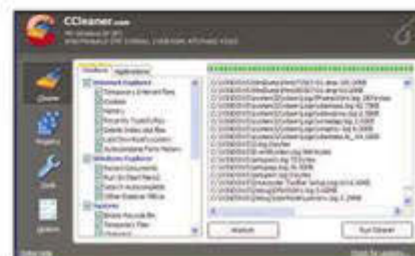
Finestra Virtual Desktops 2.5 Set up four or more virtual desktops on your PC.

IObit Advanced SystemCare 8

A complete computer security, maintenance and optimisation suite.

Revo Uninstaller Free 1.95 Remove installed applications completely, including all their folders, system files and Registry entries.

Simple Performance Boost 1.0.5 Tweak the Windows Registry to give your PC a performance boost.



Crafting PCs the Scan way: Specification. Service. Satisfaction.

OPTIONS
CUSTOM
AVAILABLE



Scan V1 Value System Home / Office PC

- Intel® Pentium® G3240 processor
- 4GB Corsair DDR3 1333MHz memory
- 500GB SATA 6Gb/sec hard drive
- Windows 8.1

£295 Inc VAT

The V1 is a very capable entry-level system perfect from basic home/office tasks. It's based around the dual-core Intel® Pentium® G3240 processor, 4GB of RAM plus a 500GB hard disk.



OPTIONS
CUSTOM
AVAILABLE



Scan V15 Value System Home / Office PC

- Intel® Core™ i5 4460 processor
- 8GB Corsair DDR3 1600MHz memory
- 1TB SATA 6Gb/sec hard drive
- Windows 8.1

£475 Inc VAT

The V15 ups the ante by including a quad-core Intel® Core™ i5 4460 processor, so it makes light work of office and multimedia applications.



OPTIONS
CUSTOM
AVAILABLE



Scan G20 Value System Gaming PC

- Intel® Pentium® G3240 processor
- 8GB Corsair DDR3 1600MHz memory
- 2GB NVIDIA GeForce GTX 750 Ti SSC
- 1TB SATA 6Gb/sec hard drive
- Windows 8.1

£479 Inc VAT

Thanks to its dual-core Intel® Pentium® G3240 processor and NVIDIA GTX 750 Ti SSC graphics card the G20i is our most affordable gaming PC. It even includes surround sound!



OPTIONS
CUSTOM
AVAILABLE



Scan G30i Value System Gaming PC

- Intel® Core™ i5 4460 processor
- 8GB Corsair DDR3 1600MHz memory
- 2GB NVIDIA GeForce GTX 960 SSC ACX
- 1TB SATA 6Gb/sec hard drive
- Windows 8.1

£675 Inc VAT

The combination of quad-core Intel® Core™ i5 4460 processor and NVIDIA GeForce GTX 960 SSC ACX graphics card ensures that the G30i can play any game you throw at it.



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- 8GB Corsair DDR3 1600MHz memory
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- 1TB SATA 6Gb/sec hard drive
- Windows 8.1

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3XS SYSTEMS



CLEAN SLATES

Tablets

Watching TV, surfing the web, playing games – tablets can do it all, and for less cash than you might think. Here's our definitive round-up of 14 of the best slates you can get

CONTENT REVIEWS

Page 80

ACER Iconia One 7 B1-750

Page 81

APPLE iPad Air 2

Page 82

APPLE iPad Mini 3

Page 83

ASUS MeMO Pad 7 ME572C

Page 84

ASUS Transformer Book T100 Chi

Page 85

DELL Venue 8 7840

Page 86

GOOGLE Nexus 9

Page 87

MICROSOFT Surface 3

Page 88

SAMSUNG Galaxy Tab S 8.4

Page 89

SAMSUNG Galaxy Tab S 10.5

Page 90

SONY Xperia Z3 Tablet Compact

Page 91

SONY Xperia Z4 Tablet

Page 92

TESCO Hudl 2

Page 93

VODAFONE Tab prime 6

WITH EVERYONE WANTING a slice of the tablet market, the competition is fierce. This has led to impressively specified tablets becoming available at ever-lower prices. What's more, once a tablet has been available for a few months, the price often drops dramatically – meaning you can get a high-specification tablet for the price of a mid-range model.

This month we've reviewed all the best tablets on the market, from budget compact models to use on the train to big-screen tablets perfect for films and games. However, there's more to choosing a tablet than just price. Here we show you what you need to know to pick the right model.

PIXEL PERFECT

As it's your main point of interaction with the device, a tablet's screen quality is vital. There are several factors that determine how good a screen is, and one of the most important of these is its resolution.

Some less-expensive tablets used to come with 1,280x800-resolution displays, but this is becoming increasingly rare. Most tablets now, even relatively inexpensive ones, have 1,920x1,200 panels, and some even go as high as 2,560x1,600, which makes for a gorgeously crisp display.

The more pixels there are, typically the sharper the text, making reading eBooks and browsing the web a generally more pleasant experience. It's also important to consider the pixel density of a screen. This refers to the resolution relative to the display size, and is measured in pixels per inch (ppi). A screen with lots of pixels packed into a small space will have a high pixel density, so making everything look sharper.

Higher-resolution screens will also make browsing web pages more enjoyable, as they require less scrolling to see all the content. We find a 1,920x1,080 display or larger is best for surfing the web. You should also take screen aspect ratio into account. Which aspect ratio is best is debatable, but some say a squarer, 4:3 ratio makes a tablet more

NEED FOR SPEED

Depending on what processor a tablet is equipped with, performance can vary widely. A fast processor will improve your overall experience in everything from navigating the operating system to how quickly apps open and how smoothly they run. Browsing performance is also a critical part of how nice a tablet is to use, so as part of our suite of tests we use the Browsermark benchmark, which reveals how a tablet will cope with rendering complicated web pages.

We also test general performance, including how well a tablet's processor and storage performs, using the Basemark OS II benchmark, and check graphics performance with Basemark X. We also run the demanding cross-platform Hearthstone game to see how a tablet copes with current games.

For the tablets running Windows 8.1 we also run our standard Windows application benchmarks to see how well they cope with standard Windows applications and tasks.

ALL SYSTEMS GO

There are three main operating systems available for tablets: Apple's iOS, Google's Android and Microsoft's Windows 8.1. Each of these will provide the basic tablet requirements such as web browsing, email and media playback, but each OS differs in

system. Nowadays that typically means either 4.4 KitKat or 5.1 Lollipop. Lollipop is the latest version, and it's arriving on more and more tablets. However, there's no guarantee that Lollipop will be present on even current tablets, so you may have to make do with the (still very competent) Android 4.4 KitKat.

With Windows 8.1 on tablets, you get the full Windows experience you might already be familiar with from your laptop or desktop PC. This means there's not a lot of need to acclimatise to the operating system. It's not a brilliant OS for tablets: the touchscreen-optimised apps are fine, but traditional Windows software can be tricky to use with your finger, so you might find yourself needing a Bluetooth keyboard and mouse.

Access to full Windows software does, however, mean a Windows 8.1 tablet could replace your laptop for many tasks, and bear in mind that you'll get a free update to Windows 10 when it arrives, which is shaping up to be a much better tablet OS. The Windows tablets we've reviewed are available with specially designed detachable keyboards, so can be classed as laptop/tablet hybrids.

ON THE APP

An operating system is only as strong as its app ecosystem. Apple's iOS still leads the way in terms of app availability, with many developers prioritising the platform, but Android has come on in leaps and bounds in recent years. One of Android's strengths is the integration of Google's services, such as Drive, Gmail and Google Maps, but these apps are also available on iOS. Plenty of apps are still only on iOS, and iOS certainly has the best selection of games and creative software, but the gap is narrowing.

Microsoft's Windows Store isn't as well stocked, especially when it comes to games. It's also missing some useful apps, such as Google's official YouTube and Drive apps.

SPACE SAVER

Your tablet can quickly fill up if you download lots of apps (especially games) or store lots of media, so it's important to pick a tablet with enough storage space. We'll tell you what integrated storage options are available. Some tablets let you expand the internal storage using a microSD card, so you can add extra storage incredibly cheaply. However, bear in mind that not all apps and games can be installed to an SD card.

BATTERY FARM

It's no good carrying a tablet around all day if its battery is constantly running out, so you'll want it to last at least eight hours to have all-day staying power. We test each tablet's battery by setting the screen to half brightness, turning on airplane mode and looping a video until the battery dies to give you an idea of how long it will last before you're scrambling for a power socket. You can find the capacity of each tablet's battery in our table on pages 94-95.

A fast processor will improve your overall experience in everything from navigating the operating system to how quickly apps open and how smoothly they run

comfortable to use in portrait mode when reading and surfing the web. If you plan on watching lots of films, a 16:9 or 16:10 ratio will mean you can fit more of a widescreen film on your display.

We also test display quality using our colour calibrator. We look at black levels, contrast ratio and colour accuracy. The last test shows how effectively the display is able to produce the sRGB colour gamut, and gives an idea of overall colour accuracy; screens that don't score well in this test are often biased towards a single colour, leading to colour casts. Although our scientific tests are a good measurement, subjective tests are just as important, and we also discuss how good each screen looks to the naked eye when displaying text and photos.

You're most likely to interact with a tablet's screen directly, but sometimes you'll want to use a larger display, such as your television or a projector screen, for watching films or viewing presentations. Devices such as the Google Chromecast HDMI dongle let you mirror your display on a larger screen, and some tablets have a Micro HDMI connection that allows you to connect a tablet directly to a TV to view your content.

terms of how easy it is to use and the programs available through its app store.

Apple's iOS has remained relatively consistent throughout its many versions, with each update bringing refinement and improvements. The latest version, iOS 8.3, wasn't a massive change from the previous version in terms of design. Although iOS 7 was a visual overhaul, the changes in iOS 8.3 have been much more subtle. There have been refinements to longstanding iOS functions, such as Spotlight now searching external sources as well as providing a way to easily find local apps or contacts on your tablet. Notifications have also been dramatically improved, allowing you to interact with them directly without having to open the app. Continuity is another big feature, allowing far greater interactivity between your iOS devices, so you can pick up calls from your iPhone on your iPad if they're connected to the same home network, for example. (See page 130 for more details.)

While with iPads you're safe in the knowledge that you'll receive iOS updates for your device for at least a few years, you're never as sure with Android. Android tablets come with various versions of the operating

ACER Iconia One 7 B1-750



£80 inc VAT • From www.argos.co.uk

VERDICT

The Acer Iconia One 7 is fast for its price and has a decent screen, but disappointing build quality and battery life

THE ACER ICONIA One 7 packs a surprising punch for a sub-£100 tablet. With an Intel quad-core Bay Trail Atom Z3735G processor and 1GB of RAM, the Iconia One 7 is deceptively quick for an entry-level tablet, and its performance levels aren't too dissimilar from our budget favourite, the Tesco Hudl 2.

In our Basemark OS II tests, for instance, the Iconia One 7's score of 869 is just 37 points behind the Hudl 2's score of 906, so you're unlikely to notice any difference when using its Android 4.4.4 operating system. Menu transitions are extremely smooth and lag-free and apps load up in a flash. This is great to see on such a low-end device, as budget tablets are often lumbered with slow CPUs that can make them a chore to use.

The Iconia One 7 isn't bad for playing games, either. In our Basemark X 1.1 graphics benchmark, it managed a respectable score of 11,789 with Medium graphics settings, which actually puts it just in front of the Hudl 2's score of 11,530. This is partly because the Iconia One 7 has a smaller, lower-resolution screen than the Hudl 2, but it nevertheless managed to hit much higher overall frame rates in both the Hangar and Dunes tests, averaging 26.9fps and 17.9fps compared to the Hudl 2's 17.8fps and 13.7fps.

The only area where the Iconia One 7 lagged behind Tesco's budget marvel was in our web-browsing tests, as its score of 806 in Browsermark pales in comparison to the Hudl 2's 1,615. However, in practice we had few complaints when using the Acer tablet, as web pages loaded promptly and showed hardly any signs of judder when we scrolled up and down. The tablet didn't stumble over pages with large numbers of images either.

Battery life is comparable, too, as the Iconia One 7's 3,420mAh battery lasted for 6h 40m in our continuous video playback test with the screen set to our standard 170cd/m² brightness level, which is only 18 minutes shy of the Hudl 2's score of 6h 58m under the same conditions. This isn't the greatest compliment, though, as this is still pretty poor by tablet standards. You'll almost certainly need to charge the Iconia One 7 every day if you want to use it on your daily commute, for instance, and other 7in tablets such as the Asus MeMO Pad 7 ME572C have almost double the stamina.

However, it doesn't take long to see why the Iconia One 7 only costs £80, as build quality is poor. It's a relatively light and slender device, at just 8.6mm thick and just 320g, and the textured soft-touch rear provides a decent amount of grip, but when a

tablet creaks and groans with every touch, it doesn't inspire a great deal of confidence.

Likewise, we only had to apply a small amount of pressure to the sides of the tablet to see a rippling effect on the screen. As a result, we don't foresee this tablet lasting very long, particularly in the hands of a child, and we'd much rather spend a little more to get a better-quality device.

This is a shame, as the Iconia One 7's 1,280x800 display is fairly decent. Our colour calibrator showed it was displaying 85.4% of the sRGB colour gamut, and its green and blue colour coverage was even across the sRGB colour space. The screen's only main weakness is its red and yellow coverage, but our test images still looked reasonably warm and vibrant.

The display is also pleasingly bright, with a peak white level of 433.2cd/m². This is great for travelling, as it helps to keep the display visible in bright lighting conditions, such as when you're outside or have the sunlight streaming in while you're on the train. Blacks look a little grey as a result, though, and our mediocre black level measurement of 0.45cd/m² confirmed this. However, the contrast ratio of 943:1 helped provide plenty of detail in our test images, and the screen's viewing angles are excellent, providing a clear image no matter how we held the tablet.

On the back you'll find a 5-megapixel camera. Although fine detail was in short supply in our outdoor photos, colours were still bright and accurate and noise was kept to a minimum. We did notice quite a lot of rainbow speckle in large areas of cloud, though, and the sheer number of blurred, fuzzy pixels means you probably won't want to use the camera for capturing important family moments. There's also an HDR mode, but this didn't really improve matters. Likewise, our indoor shots were even hazier, showing lots of blurry outlines and muddled areas of detail.

If you're happy with just uploading basic snaps to social networks, though, the Iconia One 7 has plenty of fun photo modes that let you be a bit more creative with your snaps. You get a choice of four filters, various different types of collage shots, white balance controls and six camera modes, including panorama, night and landscape. The menu options are quite fiddly, though, as the mode wheel can be a little unresponsive at times and trying to tap the side menu often brings up the notifications bar instead.

We also wish Acer didn't load its tablets with so many pre-installed apps and widgets,



as they not only take up space on the Iconia One 7's already precious amount of storage capacity, but they also clog up your app tray with several unnecessary icons. The Iconia One 7 comes with 16GB of storage, but the sheer amount of bloatware takes up a huge 1.1GB. Take away the space used up by its Android 4.4.4 operating system, and you're left with just 9.6GB for your own apps and files. Fortunately, the microSD card slot on the side of the tablet allows you to expand this up to 32GB.

That said, Acer has done very little to the overall appearance of Android, so at least you won't have to contend with fussy menu layouts or weirdly placed apps. You'll still need to remember to swipe down from the top right for settings and the top left for notifications, but otherwise this stock version of Android is very simple to use. We particularly like Acer's Double Tap feature, which you can use to wake the tablet from sleep mode, and you can even allow the tap to bypass the lock screen altogether for some extra convenience.

The Acer Iconia One 7 has a great specification and fast internals, but its build quality is so below par that we simply can't recommend it. It also has a smaller, less detailed screen than its rivals and its battery life is one of the worst we've seen from this size of tablet. The Tesco Hudl 2 may not have bundles of stamina either, but its larger, sharper display, superior build quality and more user-friendly interface put it streets ahead of the Iconia One 7, especially when it's only a little more expensive (or even cheaper if you have points on your Tesco Clubcard).

APPLE iPad Air 2

COMPUTER SHOPPER
RECOMMENDED



From £399 inc VAT • From store.apple.com/uk

VERDICT

Thinner, lighter and a lot more powerful, the iPad Air 2 is the best Apple tablet you can buy today

AFTER THE IPAD Air, we wondered where Apple could go next. The answer is the iPad Air 2, which is even thinner, lighter and more powerful than its predecessor. Impressively, Apple has managed to shave 1.4mm off the previous model's thickness, taking it down to an astounding 6.1mm. It's shed a bit of weight, too, slimming down 32g to just 437g.

Combined with the thinner case, that makes the iPad Air 2 much more comfortable to hold. Build quality hasn't suffered either, and its precision-cut aluminium case looks just as stunning as on the original Air, giving it the look and feel of a premium tablet.

To tie in with the latest iPhone line-up, the Air 2 sees the introduction of the gold model, alongside silver and space grey. All three are available in 16GB, 64GB and 128GB versions, and you can choose a Wi-Fi-only variant or one with built-in 4G as long as you're willing to pay £100 extra for the privilege.

Choosing the right amount of storage is important, as there's no microSD card slot. The 16GB version should be fine if you don't own a lot of apps, but the 12GB of available space can be restrictive if you want to keep a lot of media files on the tablet or install lots of games. With that in mind, the 64GB version for another £80 might be a better bet to make sure you have enough space.

Aside from the new size, the one change that's immediately obvious in the latest iPad is the addition of the TouchID fingerprint reader on the front. This works in the same way as it does on the iPhone, unlocking your device with the simple tap of a finger. It's quick and accurate and even works with damp fingers. TouchID will also work with Apple Pay when it eventually launches in the UK, letting you use your fingerprint to pay for goods online.

Apple has kept the same resolution as on previous iPads – 2,048x1,536 – giving it a pixel density of 264ppi. This isn't quite as high as the Sony Xperia Z4 Tablet's 299ppi, but text is incredibly sharp and there's plenty of resolution to get the most out of images, too. The Air 2 uses a fully laminated display, which combines the LCD, touch and glass front panel into a single layer. As well as making the screen thinner, it brings the image closer to the front, eliminating the air gap. Combined with the new anti-reflective coating, Apple has said that glare has been reduced by 56%.

It certainly seems to work well. Under our bright and harsh office lights, the iPad Air 2 picked up a more subtle reflection compared to the iPad Air's much harsher reflections, making the latest model more versatile under different lighting situations.

The screen's IPS panel gives you the same wide viewing angles we're used to from Apple's tablet line. It's not the most accurate display we've seen, though, as our colour calibrator showed it was covering only 90.1% of the sRGB colour gamut, which is around the same as the original Air. Brightness levels were similar, too, measuring 389.67cd/m². This pales in comparison to some of the newer Android tablets we've seen, such as the Sony's Xperia Z4 Tablet with its 98.3% coverage or the Google Nexus 9's 95.5%.

That's not to say the Air 2 has a bad screen, as it definitely produces cleaner, deeper images than its predecessor. However, even with its improved contrast ratio of 1,015:1 and deeper blacks of 0.38cd/m², it was plain to see from our side-by-side comparison tests that Apple's display is no longer the best in its class.

Apple has gone all out on performance for the iPad Air 2, as its brand-new 64-bit A8X chip adds an extra processor core, making it a tri-core chip, and bumps the clock speed to 1.5GHz. RAM has been increased to 2GB, too, and it's hands-down one of the fastest tablets we've seen. It scored a huge 2,038 in our Basemark OS II test, making it the first device to break through the 2,000-point barrier.

Graphics performance has also been boosted thanks to Apple's new Metal API, but once again it now faces tougher competition from the high-end GPUs you'll find in Google and Sony's tablets. Running Basemark X 1.1, for instance (the iOS version doesn't provide individual test frame rates), it returned an overall score of 26,285 on Medium quality settings, a long way behind the Xperia Z4's 32,659 and the Nexus 9's 38,016. Instead, the iPad Air 2's performance is more akin to the Xperia Z3 Tablet Compact, which scored 25,585. This is still more than enough to play any game available on the App Store, but it also shows just how far Android-powered tablets have come since the Air 2 launched.

Alongside the A8X is the M8 co-processor. This reads data from the iPad's accelerometer, compass, gyroscope and barometer. While this isn't particularly useful in light of Apple's decision to omit its Health app from the iPad, it does help the tablet know when it's at rest and when it's being moved around. When it's resting, it will stop hunting for networks, helping to save standby battery life.

The thinner case means Apple had to reduce the size of the battery. It's still a sizable 7,340mAh model, and it managed a respectable 9h 32m when we ran our continuous video playback test with the



screen brightness set to 170cd/m². It's still a way off tablets such as the Samsung Galaxy Tab S 10.5, Nexus 9 and Xperia Z4, but it does have excellent standby time (the iPad Air 2 barely sips power while it's at rest), so you shouldn't have to charge it too often.

The 8-megapixel camera on the back may have a smaller f/2.4 aperture lens than the iPhone 6's sensor, but in our outdoor shots it was hard to tell the difference between test shots from the two devices. The iPad Air 2's exposure was spot on across the entire frame, colours were accurate and there's plenty of detail. On the front is the new FaceTime HD camera. Like the iPhone 6's camera, this has a 1.2-megapixel resolution, but its f/2.2 aperture lets you capture more detail in dark rooms, making video chats that much clearer.

The iPad Air 2 deserves its place at the top of Apple's tablet line-up, but with so many great Android tablets now available, it's no longer our 10in tablet of choice. If you play a lot of games, it's becoming increasingly hard to recommend the 16GB version, and the 64GB model will cost you a hefty £479. At that price, you may as well go for the Sony Xperia Z4 Tablet, which has a superior screen, longer-lasting battery, better gaming performance and a microSD card slot.

However, it's the £290 Nexus 9 which should really give Apple pause for thought, as we think this fast, simple and easy-to-use tablet is more than adequate for your everyday needs. It also has a better screen, longer battery life and one of the most powerful chipsets around. The iPad Air 2 is still a fantastic tablet, but when there's so much happening on Android, it no longer wins a Best Buy award.

APPLE iPad Mini 3



From £319 inc VAT • From store.apple.com/uk

VERDICT

The iPad Mini 3 is a great tablet, but with the largely identical iPad Mini 2 available for less, it's hard to justify the price

WE'VE BECOME USED to each new Apple tablet model being significantly better than the previous generation. As a result, the iPad Mini 3 is rather a shock. It's not that it's a bad tablet, but there are hardly any significant changes over the company's previous model, the iPad Mini 2.

In fact, there are just three new things about the iPad Mini 3: it's available in gold, it has the TouchID fingerprint reader, and the Wi-Fi+Cellular version now has the Apple SIM, which is designed to work on multiple networks so you can switch between them to get the best deal for your needs.

With these changes, the iPad Mini 3 selling for the same price as the outgoing tablet wouldn't be so much of a problem if it wasn't for the fact that the iPad Mini 2 is still available for £80 less. This means that the iPad Mini 3 is no longer a product that's better than its predecessor, and we'll have to wait for the iPad Mini 4 before we see something new and different.

That said, there's no denying that the iPad Mini 3 is still one of the best-made tablets out there. Its aluminium body gives it a reassuring level of toughness and quality that you just don't get with plastic tablets. It also helps that it's one of the best-looking tablets there is, with the thin side bezels, full glass front panel and neat curved edges all adding up to make it a top-class premium product. While the iPad Air 2 may be thinner at 6.1mm, the iPad Mini 3 is hardly fat at 7.5mm.

Apple's TouchID fingerprint sensor is a nice addition, as you can unlock the tablet with a simple tap of the home button. It can even recognise a damp finger. You can also use TouchID to buy music and apps from the App Store. When Apple Pay comes to the UK, you'll also be able to use TouchID to pay for goods online as well, although not in shops as there's no NFC chip.

As with last year's model, the iPad Mini 3 has a Retina display with the same screen resolution of 2,048x1,536 as the iPad Air 2. As the iPad Mini 3 has a slightly smaller screen than the iPad Air 2, it has a higher pixel density – 326ppi versus 264ppi. The Mini 3's 7.9in screen has a 4:3 ratio compared to most Android tablets' widescreen 16:9; which one you prefer is a matter of personal taste, but we find 4:3 models easier to hold when reading websites, if not as well suited to films.

It's hard to tell the iPad Air 2 and Mini 3 screens apart. If you look hard you'll notice slightly sharper text on the Mini 3, but it's a close-run thing and you can't tell the difference in day-to-day use. However, image

quality is what's important and the iPad Mini 3 is rather disappointing on this front. Our colour calibrator showed the screen was only able to produce 67.1% of the sRGB colour gamut, which is one of the worst scores we've seen bar the Vodafone Tab prime 6 and is disappointing for an IPS display. We were also underwhelmed by its mediocre contrast ratio of 798:1, while lack levels of 0.45cd/m² are also pretty average.

Subjectively, colours still look reasonable, but the screen's quality pales in comparison to both the iPad Air 2 and other similarly sized tablets such as the Samsung Galaxy Tab S 8.4, Dell Venue 8 7840 and Google's Nexus 9. The only redeeming features of the screen are its healthy brightness levels of 365.62cd/m², which helps produce pure, clean whites, and its wide viewing angles: the screen can be seen easily from even the most extreme angles.

Inside is the same 64-bit 1.3GHz dual-core A7 SoC used in the iPad Mini 2. We'd normally expect Apple to use a newer chip in its latest model, with the A8 now available, but that's not to say that the A7 is particularly slow. With a Basemark OS II score of 1,158, the iPad Mini 3 sailed past the Samsung Galaxy Tab S 8.4, but tablets such as the Sony Xperia Z3 Tablet Compact have now closed the performance gap, so it doesn't feel quite as special as it once was.

The Xperia Z3 Tablet Compact has also caught up when it comes to gaming performance, as the iPad Mini 3's score of 26,285 in our Basemark X 1.1 graphics benchmark (the iOS version doesn't give an exact frame rate breakdown, unfortunately) is just in front of the Z3 Tablet Compact, which scored 25,585. However, the Mini 3 is still more than fast enough to run any current title without any slowdown, so you shouldn't have any trouble playing your favourite games.

As with the iPad Mini 2, the Mini 3 has a 6,471mAh battery. In our video playback battery test, the tablet lasted for 11h 4m. That's pretty impressive and means you'll get a typical day's worth of heavy use and around a week's worth of light use in between charges. We've seen small tablets from other manufacturers last a few hours longer, but it's not enough to count significantly against the iPad Mini 3.

The iPad Mini 3's camera has the same 5-megapixel sensor and f/2.4 aperture lens as



its predecessor. This is starting to show its age now, with its shots decidedly low-res. The quality of our test photos wasn't too bad in the sunshine, with the camera producing well-exposed shots, but they lacked detail.

On the front is the same 1.2-megapixel FaceTime HD camera, which can shoot video at 720p. Quality is far behind that produced by the newer camera in the iPhone 6 and iPad Air 2, but footage is still sharp and clear enough to have a decent video chat.

Apple has installed iOS 8 on the tablet (now at version 8.3), which is the newest and the best version of the OS so far, and it's particularly useful if you have multiple Apple devices. For instance, Continuity lets you make and answer phone calls on your iPhone from your tablet, so you need never miss a call if your phone's charging, for example, and you can also receive and send text messages (not just iMessages) on your iPad via your iPhone. Meanwhile, Handoff lets you take over tasks that you started on another device. You can start writing an email on your Mac, for example, before deciding to finish it off on your iPad.

However, the iPad Mini 2 also does all this, which leaves the iPad Mini 3 feeling decidedly less special and unique. This wouldn't be a problem if the iPad Mini 2 were no longer on sale, but the fact that you have to pay £80 more just to get TouchID, the option of having it in gold and an Apple SIM (which only EE supports at the moment) makes the Mini 3 feel overpriced for such minor changes.

Things get a bit more complicated as you go up the model range, as the iPad Mini 2 tops out at 32GB for £279; while the iPad Mini 3 has no 32GB model, its 64GB model costs £399, and the 128GB model costs £479. If you absolutely need more storage space, you've got no choice but to buy the new model. However, if you can make do with 16GB or 32GB, you'll get a much better deal by buying the iPad Mini 2.

ASUS

MeMO Pad 7 ME572C

COMPUTER
SHOPPER

RECOMMENDED £150 inc VAT •

From www.johnlewis.com

VERDICT

With its fast internals, excellent screen and long-lasting battery, Asus has struck gold

WITH ITS NEW 'clutch bag' design, there's no prize for guessing the demographic Asus wants to target with its latest MeMO Pad 7 tablet. However, despite looking like a purse from behind, this is an excellent all-round tablet for all genders, with a powerful chipset, excellent screen and brilliant battery life.

It's a slightly odd design, not least because of the two different textures on the sides, but this slim, lightweight tablet really is great for popping in your bag. Despite the size and weight the MeMO Pad 7 feels fantastically built, and its solid chassis feels as if it could take its fair share of knocks. Its sharp, angular corners can be a little uncomfortable when holding the tablet for long periods of time, but at least its textured rear and slightly rubberised sides give you plenty of grip.

This year's MeMO Pad 7 has an upgraded display. Instead of the previous model's 1,280x800 resolution, the MeMO Pad 7 has a generous 1,920x1,200 resolution, giving it a pixel density of 323 pixels per inch. This beats the Acer Iconia One 7's 215ppi by quite some margin, and the difference is plain to see when looking at the tablets side by side. Whereas the Iconia One 7's app icons and text are a little fuzzy round the edges, the MeMO Pad 7's are noticeably sharper.

The MeMO Pad 7's display also has one of the best IPS panels we've seen in this price

The MeMO Pad 7's display has one of the best IPS panels we've seen in this price range

range. In our tests, our colour calibrator showed the display showing an impressive 90.9% of the sRGB colour gamut. Reds were a little weak, but otherwise its colour coverage hit every other gamut boundary, ensuring rich, vibrant-looking images with more accurate colours than on the Iconia One 7.

We were also pleased with the MeMO Pad 7's high 1,338:1 contrast ratio. This produced a much higher level of fine shadow detail in our test images than Acer's Iconia One 7 could manage. The screen's peak brightness of 401.8cd/m² isn't the brightest we've seen, but it's still pretty high, and we had no trouble at all seeing the screen clearly outdoors.

The high-quality screen doesn't take its toll on the MeMO Pad 7's battery life either, as we saw an excellent 12h 7m in our continuous



video playback test with the screen set to our standard 170cd/m² brightness. This is superb for a 7in tablet, giving it roughly the same battery life as several large 10in tablets we've tested. This makes the tablet ideal for long journeys, and it should definitely keep you going all day even with heavy usage.

The MeMO Pad 7 is also a compact powerhouse. Armed with a quad-core Intel Atom Z3560 processor clocked at 1.83GHz and 2GB of RAM, it's one of the most capable 7in tablets we've tested. In Basemark OS II, for instance, it scored an impressive 1,073 overall, surpassing the Tesco Hudl 2 by almost 100 points, and its Browsermark score of 1,548 means web browsing is supremely smooth, even when there are several images onscreen.

It's also good for playing games, as it managed a massive 17,865 in our Basemark X 1.1 graphics benchmark on Medium quality settings, averaging 21.8fps in the Dunes test and 29.0fps in the Hangar test. Frame rates dropped to 16.6fps and 14.2fps respectively when we switched over to High quality settings, but its overall score of 11,149 is still great for a £150 tablet.

The MeMO Pad 7 has just been upgraded to Android 5.0, so you needn't worry about buying an out-of-date tablet. Instead of just using stock Android, Asus has used its own Zen UI skin, which gives the tablet its own unique look and feel. In terms of appearance, it's not too dissimilar from stock Android, as you still have an app tray that houses all your applications, and a notifications and quick settings menu that's accessible by swiping down from the top of the screen.

We particularly like how Zen UI makes the most of the lock screen, as here you'll find the time, weather and date, along with three customisable shortcut buttons to open any app of your choice. The buttons are set to open the camera, web browser and basic email application by default, but you can

change them to open any trio of apps you like in the Lock Screen settings.

The MeMO Pad 7 comes with a lot of pre-installed apps, but Asus's app tray has several features to help ease any problems with organisation. Its handy Smart Folder option can group app tray programs into folders, making them easier to find, and you can uninstall or disable apps directly from the app tray instead of going into the main menu. You can also adjust the grid size of the app tray to fit more apps on a single page, hide certain apps from view, or lock apps in place so you don't have to go hunting for them.

On the back is a 5-megapixel camera. While detail is never going to be in huge supply with a sensor of this size, we were pleasantly surprised by the quality of our photos, as colours looked accurate and the camera's HDR mode effectively captured the correct exposure of the sky and ironed out dark patches of shadow. HDR mode also heightened smaller areas of contrast as well, making window ledges and street signs, for instance, really pop out of the picture.

There are plenty of extra camera modes, too, including Panorama, Night, Selfie, Beautification and Time Rewind, which takes several shots at once and lets you pick the best one using its responsive onscreen slider. There's also Miniature mode, which blurs everything outside a pre-defined circle or rectangle onscreen to let you focus on tiny details, and a Depth of Field mode, which is surprisingly effective for close-up macro shots. There's even a GIF maker for creating short animations which you can either speed up or slow down on the post-editing screen.

With so many versatile features, the Asus MeMO Pad 7 ME572C is by far one of the best compact tablets around. It's reasonably priced at £150, and provides an excellent step up from the Tesco Hudl 2 if you want something small that's faster, has better battery life and a more colour-accurate screen. It's also recently received an Android 5.0 update, which is more than can be said for other tablets we've tested in this price range. The Hudl 2 is still a great buy, but if your budget can stretch the extra £50, the MeMO Pad 7 ME572C has some distinct advantages.

ASUS Transformer Book T100 Chi



£400 inc VAT • From www.pcworld.co.uk

VERDICT

The successor to one of our favourite tablet hybrids fails to keep its crown with an increased price and some questionable design decisions

THE ASUS TRANSFORMER Book T100 was one of the best-value and most attractive laptop/tablet hybrids we saw last year. However, things have moved on since then and Asus's latest Transformer Book T100 Chi has introduced a string of new changes to try and help it keep up with its latest rivals, such as the Microsoft Surface 3. However, we feel not all the changes have been successful, and it's these questionable updates that sadly unseat the new T100 from its throne.

The 10.1in Transformer Book T100 Chi uses the same basic design as the old model, with the tablet section of the device easily detachable from the keyboard base. However, although the old T100 connected to its keyboard through physical ports, the Transformer Book T100 Chi dumps these connectors in favour of Bluetooth pairing.

At first, this seems a sensible step. The keyboard base has a toggle switch that turns it on, off and into discoverable mode so you



Book T100 Chi at the same time. It's a shame this connector has been removed as it only makes the new device slightly slimmer than the old one – 22mm compared to 24mm.

Aside from the impractical USB connector, you also get a 3.5mm headset jack, a Micro HDMI port and a microSD card slot. All is not lost if you want to use a proper mouse with your tablet when you're at a desk, but it will have to be a more expensive, battery-powered Bluetooth unit instead of a conventional wired mouse. If you want to get work done, though, the small keyboard feels a bit cheap and isn't brilliant for long periods of typing.

adequate but not particularly punchy overall image. Viewing angles are wide, which is a relief as there's very little hinge adjustment for the screen, meaning the display won't always be at the perfect angle when you're trying to get some work done.

Despite the £50 price increase, performance hasn't increased significantly over the old model. We ran our old Windows application benchmarks to see if the Transformer Book T100 Chi's quad-core 1.46GHz Intel Atom Z3775 processor is much of a step up from the 1.3GHz chip in the 2013 model. It's a modest improvement, scoring 27 overall where the old model scored 22. While the numbers look reasonable, actual day-to-day performance was a mixed bag. Often we found applications hanging, and web pages could take an age to load.

Battery life in our video playback test was average for a Windows tablet, at just under nine hours. Getting through a full day of media consumption or work on one charge is questionable, but the Micro USB power supply is light and compact so you should keep it with you at all times just in case.

You get 64GB of storage, of which around 40GB is free with a Windows 8.1 install – the same as on the entry-level Surface 3. This should be enough if you don't have a huge photo or video collection, although you can expand the storage with a microSD card.

We're a little underwhelmed by the Asus Transformer Book T100 Chi. It's not particularly light or compact, and it lacks the ports that would make it a legitimately useful laptop, which seems like a step backwards to us compared to the previous Transformer Book. Moreover, the basic model of the Microsoft Surface 3, which also has 64GB of storage, costs just £20 more and has a full-sized USB port, a better screen and a faster chipset. Admittedly, the Surface 3 doesn't come with a keyboard (this will cost another £110 if you don't already have a Bluetooth keyboard), but it's still a more useful and appealing Windows hybrid.

The keyboard charges separately from the tablet, so when it eventually runs low, you'll need a Micro USB charger

can pair it with other devices. The prongs that hook it into the tablet have no electronic components and are instead purely magnetic. This means the tablet portion is firmly connected to the keyboard base and can be detached by simply pulling the tablet away without any need for a release button.

This works well, but the lack of a physical connection is a strange feature that might cause annoyance. Most notably, the keyboard charges separately from the tablet, which means when it eventually runs low, you'll need to use a Micro USB charger to ensure you can carry on using the device effectively. The second problem, which is admittedly more niche, is that if you strictly adhere to in-flight safety rules on some airlines, you won't be able to use the keyboard at all since it requires a Bluetooth connection at all times.

There are other design decisions that affect practicality, including the loss of the full-size USB connector on the keyboard base. Instead, your only USB host connection comes in the form of a USB3 Micro-B connector, and there's no adaptor in the box. This means you'll struggle to connect more than one wired peripheral to your Transformer

The tablet weighs 571g by itself, making it lighter than the Surface 3, but the keyboard adds another 536g to the overall weight for a total of over a kilogram. This makes the Transformer Book T100 Chi feel pretty hefty by comparison when you're carrying it around in your bag. Still, as a tablet, it's perfectly usable, and the included Bluetooth stylus is a big help when it comes to precision tasks.

Practicality issues aside, the Transformer Book T100 Chi has a decent screen for such a small and relatively inexpensive hybrid. You get a 10in 1,900x1,200-pixel display, which makes everything look very sharp, and its pixel density of 224 pixels per inch beats the Surface 3's 213ppi. However, it won't do your eyes any good, as smaller objects onscreen don't scale particularly well in Windows 8.1. This shouldn't be a problem if you're using well-supported applications such as Google Chrome and Microsoft Office, but it might be a problem with software packages that don't have well-optimised display scaling features.

While the resolution impresses, actual colour accuracy is only average, with the 69% sRGB gamut coverage, 742:1 contrast ratio and 0.34cd/m² black level contributing to an

DELL Venue 8 7840



£369 inc VAT • From www.dell.co.uk

VERDICT

The Venue 8 7840 is a super-stylish Android tablet with an innovative camera

WE HAVEN'T SEEN many Android tablets from Dell; the company's last attempt, the Venue 8 Android, was highly competent but hardly set our hearts aflutter with its design. The Venue 8 7840 is a different kettle of fish. It's a truly desirable Android tablet, with a gorgeous slim aluminium chassis and a super-high-resolution AMOLED display.

At just 6.1mm thick, the metal chassis is cool to the touch, and the rounded corners don't dig into your hands. The screen has slim bezels on three sides, but the bottom bezel is significantly larger. This is where you'll find two of the tablet's party tricks: incredibly loud MaxxAudio speakers and three cameras for Intel's RealSense depth-aware photo tech.

RealSense uses three cameras to measure depth in your photos. This gives you access to some fancy effects, such as selective focus, the ability to apply effects to certain areas of the photo, and even to measure the length and area of various objects in the frame.

The main camera sits right at the bottom of the tablet, with the two depth cameras above it. This immediately causes a problem, as your hand will most likely obscure the camera whether you hold the tablet to take a photo in portrait or in landscape mode. We found the best way to take a picture was to grip the tablet with our fingertips, but this meant we obscured some of the screen while composing photos.

The camera's image quality didn't blow us away: daylight images showed accurate contrast but significant noise, and elsewhere noise reduction led to some smudginess. Low-light photos were nothing special either, and we had a lot of trouble getting a sharp, shake-free shot under indoor lighting.

RealSense uses three cameras to measure depth. This gives access to some fancy effects, such as selective focus and the ability to apply effects to certain areas of the photo

However, we had fun with the camera's depth sensors. Once you take a photo, you can use the app to make adjustments using the depth information captured by the secondary sensors (you have to drop out of the camera app to select an image to edit, rather than being able to get on with it as soon as you've taken the photo, which is annoying). We particularly liked the ability to drain colour from an image depending on how

far objects were from the camera; we turned a group of three people with one standing slightly behind the other into two people and a ghostly black and white apparition.

Selective focus works well enough, but apply too much of the effect and you'll see significant artefacts around the edge of the subject you've chosen to keep in focus. Edits are non-destructive, as the original image is kept in the tablet's DCIM folder. Distance judging wasn't quite up to scratch, however. In one test photo, the camera was convinced that a toy samurai warrior one foot from the camera was taller than a person standing eight feet away, which rather messed up the artistic effect we were trying to achieve.

The measurement tool is potentially very useful. It can measure the distance between two points or the area of an object, so could be handy for anything from working out someone's height to seeing if the sofa you fancy in DFS will fit through your door. Unfortunately, we had mixed results, and couldn't find a way to measure in metric rather than imperial units. We managed to measure a person accurately when they were standing upright, but a 12-inch ruler was around three inches out, and one side of a painting was twice as long as another. It's generally impressive, but it relies on the application of common sense and should only be used to get an idea of measurements.

Fancy camera aside, the Venue 8 7840 is an impressive tablet. In our tests, the tablet's screen was capable of displaying 100% of the sRGB colour gamut, and as it's an AMOLED model, blacks are truly black, measuring 0.00cd/m². The operating system feels like it's just under your finger, and Android's icons

and text look sharp, clear and vibrant. However, the screen isn't as bright as other AMOLED displays we've seen, such as the Samsung Galaxy Tab S 8.4's, with a maximum brightness figure of 261.67cd/m² compared to 296.92cd/m² for the Samsung.

The Venue 8 7840 has a quad-core 2.33GHz Intel Atom Z3580 processor, which produced impressive performance in our benchmarks. It managed a fast score of 1,270



in our Basemark OS II test, putting it way out in front of Samsung's Galaxy Tab S 8.4, but we noticed some lag when scrolling around web pages and occasional stuttering animations when opening and closing apps.

The tablet managed a huge 19,371 in the Basemark X 1.1 graphics benchmark, averaging 18.9fps in the high-quality Dunes test and 24.7fps with the quality set to Medium. While this is still almost 20,000 points behind the Nexus 9, the Venue 7840 could play Blizzard's Hearthstone smoothly, apart from some jerky intro animations. The tablet is currently running Android 4.4.4, but Dell has promised an imminent update to Android 5 Lollipop, which should hopefully smooth out some of the performance bumps. In our continuous video playback test we saw 14h 20m when the screen was set to our standard 170cd/m² brightness, which is up there with the best tablets we've seen, such as the iPad Air 2.

Although we had some fun testing it, the Dell Venue 8 7840's depth-sensing camera feels more like a gimmick than a reason to buy. This isn't a particular reason to worry, as the tablet itself is a desirable piece of kit, with lovely build quality and an excellent screen. However, it's not the quickest tablet we've seen, and it simply can't beat the Nexus 9 for sheer performance. Its display also has some serious competition from the cheaper Samsung Galaxy Tab S 8.4. Neither of these tablets are as beautifully made as the Dell tablet, but it does make the Venue 7840 seem less good value by comparison. Still, if you want a tablet that you can really show off, the Dell Venue 8 7840 is a good choice. It wins a Recommended award.

GOOGLE Nexus 9

COMPUTER SHOPPER



BEST BUY

From £290 inc VAT •

From www.expansys.com

VERDICT

The fastest Android tablet to date, the Nexus 9 raises the bar for Google-powered slates

WITH ITS FIRST tablet, the Nexus 7, Google provided a brilliant bargain alternative for those unwilling to spend £400 on an iPad. Larger Android tablets, including Google's own Nexus 10, had less success against the iPad, and it appeared for a while that Google had no stomach to take on Apple head to head.

The 8.9in Nexus 9 changes all that. Its 4:3 ratio display makes it more iPad-like than any other major Android tablet, and the high-quality design and materials are also a match for Apple's finest. In size, it's a reasonable alternative to both the 9.7in iPad Air 2 and the 7.9in iPad Mini 3, but its recent price cut to £290 gives it a big advantage.

Google has partnered with HTC to manufacture the Nexus 9, which is one of the most appealing and well-made Android tablets around. At just under 8mm thick, the Nexus 9 isn't the slimmest tablet – the Air 2 and Sony Xperia Z4 Tablet are noticeably slimmer at 6.1mm – but it is incredibly light, weighing 425g. There's also a brushed metal trim around the edge, which is polished to a silver gleam along its top, while the casing comes in black, white or sand, although the latter is available only on the 32GB model.

On the plus side, the colours are all complementary and the edges are largely free of buttons, flaps, ports and slots, making for a more streamlined look. Details on the back, such as the camera lens protruding from the curved corner and the recessed Nexus logo, also add a bit of class to the tablet, but the slight amount of flex in the plastic rear panel falls short of the iPad Air's metal casing.

We also feel the power and volume buttons could do with being a bit deeper, as their rather flush position doesn't provide a lot of travel and they can be a bit tricky to locate if you're just running your finger along the tablet's edge. Fortunately, you can always wake the tablet by double-tapping the screen instead, so you don't necessarily need to press the power button to turn the screen on.

Like all Google's Nexus devices, there's no microSD expansion slot, so you'll need to be sure about how much storage you need when you order. The 16GB model is £290, while the 32GB model costs £350; £60 is a huge premium to pay for just 16GB of extra storage space, as you can get 48GB of extra storage for £80 if you decide to upgrade to the 64GB iPad Air 2. You can get a more reasonable deal if you buy the 32GB 4G model of the Nexus 9, though; £410 is a reasonable price for a 4G 32GB tablet, compared to the £499 and £579 you'll pay for a 16GB or 64GB 4G iPad Air 2.



The standout feature of the Nexus 9 is its 4:3 ratio screen. The vast majority of Android tablets, from the likes of Sony and Samsung, use widescreen displays of 16:10 or 16:9. The Nexus 9, therefore, has more in common with Apple's 4:3 iPads. We generally prefer 4:3 for using tablets in portrait mode, especially when web browsing, but this screen ratio is arguably less practical for watching films or TV as you'll end up with black bars at the top and bottom of the screen. This doesn't seem to put off all those iPad Netflix users, though.

The display is one of the Nexus 9's stronger elements. Its 8.9in screen has a 2,048x1,536 resolution, the same as the iPad Air 2, and a pixel density of 264ppi. This makes for nice, sharp text and provides plenty of space for reading web pages, regardless of whether the tablet is in portrait or landscape.

The panel itself is also one of the best we've seen. Our measurements showed it was displaying 95.5% of the sRGB colour gamut, which is higher than the iPad Air 2's 90.1%. The Nexus 9's display is also incredibly bright at 455.69cd/m², making it one of the brightest displays we've used. Black levels are good too, at 0.38cd/m², and we measured the screen's contrast ratio as an excellent 1,195:1. Photos look gorgeous, with nicely saturated colours.

The Nvidia Shield Tablet was the first device we saw with an Nvidia Tegra K1 system-on-chip, but the Nexus 9 is the first device to use the full-blooded 64-bit version of the processor. While the Nvidia Shield Tablet has four cores that operate at 2.2GHz, the Nexus 9 has only two, but these run at 2.3GHz and are based on the newer 'Denver' CPU. The Nexus 9 also comes with 2GB of RAM.

The Nexus 9 scored an outstanding 1,739 in our Basemark OS II benchmark, making it one of the most powerful and fastest tablets we've tested. Likewise, its huge Browsermark score of 2,336 made for some incredibly slick web browsing, as pages loaded quickly and scrolling produced no stutter whatsoever.

The Nvidia Tegra K1 is no slouch when it comes to gaming performance, either. The Tegra K1 is built around Nvidia's Kepler GPU architecture with 192 Nvidia CUDA cores. Unsurprisingly, it blitzed through our Basemark X 1.1 graphics benchmarks, scoring

a massive 38,016 on Medium quality settings (averaging an impressive 38.5fps in the Dunes test and 53.7fps in the Hangar test) and 28,525 on High quality settings, with an average of 35.3fps in Dunes and 34.2fps in Hangar.

The Nexus 9's 6,700mAh battery helped it to an impressive performance in our continuous video playback test, too. Google only rates the Nexus 9 for 9½ hours of video playback, but with the screen set to 170cd/m² brightness, we saw 12h 31m before the battery gave out. This doesn't quite beat what we've seen from Sony and Samsung's little and large tablets, but it's a good three hours more than either of Apple's iPads can manage.

The Nexus 9 has a 1.6-megapixel camera on the front and an 8-megapixel camera on the back. Both lenses have an f/2.4 aperture. As far as tablet cameras go, it's not too bad, but a fair distance away from the quality of the iPad Air 2's sensor. In our outdoor shots, the colours the camera produced were slightly muted, and images weren't as sharp as we would have liked. There was also noticeable noise in the shadow details, and some images came out slightly underexposed.

Naturally, the Nexus 9 runs the latest version of Android, 5.1. This is a pure version of Android, so you won't find any modifications made by vendors on their own-brand devices. Android 5 is a huge improvement over Android 4.4 KitKat, as Google's new Material Design scheme flattens a lot of the user interfaces and introduces card-based menus that look very similar to Google's context-sensitive Google Now service. Notifications also appear on the lockscreen and can be expanded with a simple double tap, and the Settings menu's quick toggle buttons are now accessed by a second pull of the notifications panel or a two-finger swipe from the status bar.

The Nexus 9 is among the best tablets we've seen. The screen is wonderful, battery life is fantastic and the build quality and design are close to the very best from Samsung, Sony or Apple. If you're looking for a powerful Android tablet, nothing else even comes close right now, and at £290 it's a real bargain compared to either of Apple's mighty iPads. It wins a Best Buy award.

MICROSOFT Surface 3

COMPUTER
SHOPPER
RECOMMENDED



£499 inc VAT • From www.microsoftstore.com

VERDICT

It's expensive, but the Surface 3 is a superb Windows tablet with a first-class display

WE DIDN'T THINK we'd see another Surface tablet before Microsoft launched Windows 10, so the Surface 3 comes as a welcome surprise, particularly if you thought its big brother, the £639 Surface Pro 3, was too expensive. The Surface 3 works as a tablet, but comes into its own when paired with a Type Cover keyboard, which turns it into a tablet/laptop hybrid.

Unlike previous Surface models, which ran the limited Windows RT operating system, the Surface 3 runs full 64-bit Windows 8.1 (with a free upgrade to Windows 10 later this year), letting you download and install any third-party Windows program just as you would on an ordinary PC. This gives it a huge advantage over the original Surface and Surface 2, which restricted you to apps from the Windows Store.

We were big fans of the Pro 3's silver magnesium chassis, so we're pleased to see Microsoft using the same material for the smaller Surface 3. At just 8.7mm thick and weighing a featherweight 622g, it's slim for a hybrid laptop if not for a tablet, but any thinner and Microsoft wouldn't have been able to fit a full-sized USB3 port on the side.

This makes it more versatile than other Windows tablets as it means you can plug in a wireless keyboard or mouse if you don't fancy paying another £110 for a Surface Type Cover keyboard. You'll also find a microSD card slot, a Mini DisplayPort output and a headphone jack. The Surface 3 charges over Micro USB, so you can carry one power supply to charge both your tablet and your phone.

The 10.8in 1,920x1,280 display means the tablet is more compact than the Pro 3, but it's also slightly less practical as a result. This is because the inch difference in diagonal screen size between the two tablets' screens equates to a 23% difference in physical viewing area. This is particularly noticeable when working on two documents at once; although there are enough horizontal pixels, your eyes may struggle with the screen's relatively small size.

Still, being restricted to viewing one document at a time is a small price to pay when the screen's image quality is so good. According to Microsoft, the Surface 3 has the most accurate display of any tablet, and the impressive results in our colour calibration tests back up these claims. The Surface 3's panel was displaying an outstanding 97.2% of the sRGB colour gamut, which is higher than Apple's new MacBook and almost every other non-AMOLED laptop and tablet we've tested.

The Surface 3's screen is also bright; our calibrator measured its peak brightness as a very high 410.18cd/m². This is more than enough for working outside in the sunshine

(although you'll need to set the brightness to maximum in order to do so), and it helps keep whites looking clean and pure. Black levels were less impressive at 0.46cd/m², but text still looks solid enough when reading web pages and typing Word documents.

The display has wide viewing angles, which meant we were able to see onscreen images clearly from a wide variety of angles, which is particularly important as the Surface 3's rear kickstand has only three set positions. It's a shame this isn't as flexible as the Surface Pro 3's kickstand, but the steepest angle still gives you plenty of clearance to work comfortably on a train, for instance, while the widest is perfect for typing out a quick email at home with the Surface 3 on your lap.

The Surface 3 is powered by one of Intel's new Cherry Trail Atom processors, the quad-core 1.6GHz X7-Z8700. The tablet is fanless, too, so makes no noise at all. The Surface 3 scored a respectable 30 overall in our application benchmarks, which puts it ahead of other Atom-based tablet hybrids such as the Asus Transformer Book T100 Chi.

This is more than enough speed for general tasks such as web browsing and composing Office documents. However, even our model, which had 4GB of RAM as opposed to the £419 model's 2GB of RAM, struggled with the multitasking section of our benchmarks, so it may start to slow down if you're running lots of demanding programs at the same time.

The Surface 3's battery will just about get you through the day on a single charge. Microsoft says the device is rated for nine hours of video playback, but in our continuous video test we saw 7h 48m. This isn't bad for a Windows tablet, but it also shows that Microsoft's figure is a little optimistic, so you'll need to keep an eye on the battery meter when you're on the move.

The Surface 3 doesn't come with a Type Cover keyboard in the box, so you'll need to add another £110 to the cost of the tablet if

you want to buy one. However, unless you already own a Bluetooth keyboard, we feel it's a pretty essential accessory. Thankfully, rather than shrink the keys to fit the Surface 3's smaller screen, Microsoft has kept the keys the same size as on the Pro 3's keyboard, but sheared off the excess space round the sides to match the correct width of the display.

The keyboard attaches via a small magnetic strip on the bottom of the tablet to lie flat, and can also attach to the bottom of the screen's bezel to sit at a raised angle for more comfortable typing. The pressure-sensitive Surface Pen is now an optional extra with the Surface 3, so you'll have to pay another £45 for its excellent note-taking and drawing abilities.

The keys are backlit, which is great for working in low light, and the raised angle brings a welcome sense of stability to the keyboard if you're typing while reclining on the sofa, for example. There's a small amount of flex in the keyboard, but it didn't bother us and the great level of tactile feedback meant we were typing at normal speed in no time.

The Type Cover's touchpad is still pretty small, but we found it afforded plenty of space for moving the cursor round the screen, and multitouch gestures such as pinch-zooming and two-finger scrolling were incredibly responsive.

When you add in the various accessories, the overall cost of a Surface 3 can quickly feel like it's ballooning out of control, but it's by far one of the most capable and attractive Windows hybrids we've seen. We much prefer it to Asus's Transformer Book hybrids, and its display is one of the best around. A free subscription to Office 365 Personal adds extra value to the device, and the Surface 3's tiny size certainly beats carrying around a bulky laptop when you're travelling. It may not have the speed or battery life of the larger Surface Pro 3, but if you're looking for a more wallet-friendly way of replacing your old laptop, the Surface 3 is a great choice.



SAMSUNG Galaxy Tab S 8.4



£250 inc VAT • From www.currys.co.uk

VERDICT

A stunning screen, but the competition has hotted up since the Tab S 8.4 launched

YOU CAN'T HELP but be impressed by the Samsung Galaxy Tab S 8.4's display. As soon as you're greeted by the lock screen it's apparent the tablet has an incredibly high-res panel. With a 2,560x1,600 resolution crammed into an 8.4in display, this equates to a pixel density of 356ppi, which makes it nigh-on impossible to spot any individual pixels.

The Super AMOLED display is the Galaxy Tab S 8.4's crowning feature, eclipsing displays on other similarly sized tablets such as the Sony Xperia Z3 Tablet Compact and Apple iPad Mini 3. AMOLED provides rich and vibrant colours, with fantastic contrast and saturation, so much so that our colour calibrator returned a perfect score of 100% coverage across the sRGB colour gamut. The colour saturation was so pronounced, in fact, that it took a while for our eyes to adjust, and after using the Galaxy Tab S 8.4 for a while other displays looked flat. Blacks were a perfect 0.00cd/m², too, allowing text to really stand out against white backgrounds.

The downside of AMOLED displays is that they aren't generally as bright as their LCD counterparts. The Galaxy Tab S 8.4's display reached a peak brightness of 296.92cd/m² in our tests, which is significantly dimmer than the Tesco Hudl 2, Nexus 9 and Sony Xperia Z3 Tablet Compact. However, the panel's vibrant colours help to make up for this deficiency, and Samsung's Adaptive Display setting helps to make sure the display appears at its best by adapting to the ambient light conditions.

The Adaptive Display sensor is more advanced than the auto brightness you typically see with smartphones or tablets as it adjusts gamma, saturation and sharpness rather than just brightness levels. We found it worked well, adjusting seamlessly and helping to avoid colour casts, so we opted to leave it on. Disappointingly, it only works in specific apps and isn't universal, so many third-party apps won't benefit from the feature.

At just 6.6mm thick and 294g, this is Samsung's thinnest and lightest tablet yet, and it certainly feels svelte in the hand. It has a slightly dimpled, soft-touch polycarbonate back that makes it comfortable to hold, and there's reassuringly no flex in the casing.

Samsung has used its own octa-core Exynos 5 system-on-chip (SoC) processor to power the Galaxy Tab S 8.4, which was first seen on the 2014 model of the Galaxy Note 10.1. It's technically a quad-core ARM 1.9GHz Cortex-A15 paired with a quad-core 1.3GHz Cortex-A7 filling in when only a less power-hungry processor is needed. There's also a 4G model available that uses a quad-core

Qualcomm Snapdragon 800 processor running at 2.3GHz, but all models come equipped with a generous 3GB of RAM.

In our Basemark OS II benchmarks the Exynos 5 model scored 700 overall. This is a little lower than we were expecting, as it's almost 200 points behind the Tesco Hudl 2. Still, we had no complaints about day-to-day performance, as apps opened exceedingly quickly and Samsung's TouchWiz interface felt extremely smooth and responsive.

The tablet's Browsermark score of 764 was also below average, but this was more noticeable when we began browsing the web. Scrolling up and down web pages, for instance, was a little too juddery for our liking and sometimes there was a noticeable delay when we zoomed in and panned round pages. We'd expect more from a £250 tablet, and but at least you'll be able to play games on it without too much trouble.

Despite its modest score of 14,111 on Medium quality settings in Basemark X 1.1, averaging 13fps in the Dunes test and 18.7fps in the Hangar test, the Galaxy Tab S 8.4 proved more than capable of playing demanding games such as Hearthstone, as we saw almost no judder whatsoever. In-game animations in particular were smoother than on other 8in tablets we've tested, and it certainly goes a long way to make up for its slightly lacklustre web performance.

Likewise, the Galaxy Tab S 8.4's battery life is outstanding, as it lasted 13h 54m in our continuous video playback test with the screen brightness set to 170cd/m², making it longer-lasting than the iPad Mini 3 or the Xperia Z3 Tablet Compact. The Dell Venue 8 7840 still has the edge with its battery life of 14h 20m, but you should definitely be able to get a full day's use out of the Galaxy Tab S 8.4 however you're using it.

The Galaxy Tab S 8.4 has just been upgraded to Android 5.0, and Samsung has included a few of its own tweaks to the Android operating system. One of the more notable is Multi Window mode, which allows you to use two apps simultaneously. This is useful if you're watching a film and want to open the browser to look up an actor, for example, and each app is resizable. Kids Mode has also been included, allowing a safe ecosystem for children through parental controls and a custom child-friendly interface, meaning you should be able to safely hand the tablet to your little ones.

As with Samsung's current flagship smartphone, the Galaxy S6, a fingerprint scanner has been incorporated into the Home



button which gives you a more secure way to unlock your device, log in to your Samsung account or pay for PayPal purchases. You can register up to three fingers per user, and we found the scanner works consistently provided you make sure you register your swipes correctly. Using the fingerprint scanner proved much faster than entering pin codes or dealing with pattern unlocks and was our favoured method of verification. Samsung is expected to open the API to third-party apps, so we're hoping to see it as a verification option in other apps in the future.

Around the back is an 8-megapixel camera with an LED flash. We were impressed with how the camera performed. The camera supports image stabilisation for both video and still images, which we found helped under tough low-light conditions and allowed for sharper images when slower shutter speeds were needed. There are also modes for HDR, Panorama, Burst Modes and Dual Camera, which allows you to use both cameras at the same time, which is a surprisingly fun feature we first saw on the Samsung Galaxy S4. Overall, the camera captures decently sharp images, with good saturation, and low-light noise was kept under control.

The Samsung Galaxy Tab S 8.4 is a lovely tablet with a standout screen that beats the iPad Mini 3, Sony Xperia Z3 Tablet Compact and the Google Nexus 9. It's thin, light, has good battery life and some nice tweaks to Android, and it's also £70 cheaper than when it first launched a year ago, with prices now starting from £250. However, the competition has also dropped in price since then, and we think the sheer speed and more attractive waterproof design of the £265 Sony Xperia Z3 Tablet Compact just pips the Galaxy Tab S 8.4 to the post. The Galaxy Tab S 8.4 is still an excellent tablet but, despite its price drop, it's no longer as good value as it once was.

SAMSUNG

Galaxy Tab S 10.5

COMPUTER
SHOPPER
RECOMMENDED



£350 inc VAT • From www.currys.co.uk

VERDICT

An incredible screen at a reasonable price; if you don't need the best possible performance, it's a great 10in tablet

SAMSUNG HASN'T ANNOUNCED a new crop of big-screen tablets yet this year, but after 2014's superb Galaxy Tab S range, we can understand why. With its high-resolution 2,560x1,080 Super AMOLED panel, the Galaxy Tab S 10.5 still has one of the best screens around, putting up serious competition to the iPad Air 2, Google's Nexus 9 and even the new Sony Xperia Z4 Tablet. It's also received a £50 price drop since it first launched, too, making it better value than ever.

The Tab S 10.5's screen uses a slightly different AMOLED technology to Samsung's smaller Tab S 8.4, which has a pentile pixel arrangement, where there are two subpixels per pixel (red and green or blue and green) instead of three (red, green and blue). The Tab S 10.5, on the other hand, has what Samsung calls 'S Stripe', where each pixel has a rectangular red and a green pixel and a longer, thinner 'stripe' blue pixel, so each pixel has the full three sub-pixels.

The larger number of sub-pixels on an RGB stripe display can lead to sharper text and more accurate colours compared to pentile. Samsung claims it had to use the pentile arrangement on the Tab S 8.4 in order to fit so many pixels into the smaller screen, but had no such problems with the larger Tab S 10.5. Despite the Tab S 8.4's screen's supposedly inferior technology, we struggled to find fault with it when compared to the Tab S 10.5 in normal use. Text on the Tab S 8.4's screen had a slight cross-hatch effect, while the Tab S 10.5's text consists of pure, solid lines, but you really need to try to spot it.

As a result, both screens look superb and each one is incredibly vibrant. As with its little brother, our calibrator returned a perfect 100% sRGB colour gamut coverage for the Galaxy Tab S 10.5, which compares well to its big rivals, the iPad Air 2 and Xperia Z4 Tablet: Apple's top-end tablet scored just 90.7% in the same test, while the Z4 scored 98.3%.

During subjective testing, however, the picture became a bit more muddled. When browsing web pages, we preferred the Z4 Tablet's and iPad Air 2's screens as whites looked cleaner and text more solid. The Tab S 10.5's screen looked slightly yellow by comparison, but this is a common problem associated with AMOLED displays. The same was true when we switched to viewing photos, as the Tab S 10.5's screen made our images look oversaturated by comparison.

Samsung does have a secret display weapon up its sleeve, though: the Tab S 10.5

has an Adaptive Display feature that uses an RGB sensor to automatically adjust the colour range, saturation and sharpness of the screen based on the content you're viewing at the time. It makes a huge difference when it's turned on, and the sheer richness of colour and fine shadow detail on show was vastly superior to what we saw on the iPad Air 2.

This is quite an achievement for Samsung, but its victory was a rather muted one once we put the Tab S 10.5 next to Sony's Xperia Z4 Tablet, as Sony's display was the clear winner for visual fidelity. Moreover, the Adaptive Display only works with a limited number of apps, such as the Gallery, Samsung's proprietary internet browser and video player and Google Play Books, so you won't get the benefit in every application.

The Xperia Z4 Tablet does cost an extra £150, though, and for its price, the Tab S 10.5 still has one of the best displays around. That quality is matched by the tablet's design, too. The Tab S 10.5 feels well made, with no flex in the chassis. At 6.5mm, it's not as slender as the iPad Air 2 or Xperia Z4 Tablet, but there's not much in it when you hold each of them in your hand. Likewise, the Tab S 10.5 is a fraction heavier at 465g, but this isn't surprising given its larger screen.

The tablet's Home button doubles as a fingerprint scanner, which you can use to unlock the device, log in to your Samsung account or pay for items with PayPal. You can register up to three fingers, and we had no problems registering our fingers or thumbs. It quickly became our favourite way to unlock the tablet.

The Galaxy Tab S 10.5 uses Samsung's eight-core Exynos 5 Octa system-on-a-chip, which consists of four ARM Cortex-A15 cores running at 1.9GHz and four Cortex-A7 chips running at 1.3GHz. The trick is that the less powerful, and therefore more energy-efficient, cores can take over for less intensive tasks, helping to prolong the tablet's battery life. It certainly seems to do the trick, as the Tab S 10.5 lasted an excellent 13h 27m in our

continuous video playback test with the screen brightness set to our standard 170cd/m² brightness. This surpasses both the iPad Air 2 and the Nexus 9, so even the most power-hungry users should be able to get a full day's use out of the Tab S 10.5 without having to return to the mains.

Admittedly, the tablet only completed our Basemark OS II test with a measly score of 816, which is slower than the budget Tesco Hudl 2 managed. However, Samsung's TouchWiz interface showed no signs of lag when opening and closing applications, and its various animations, such as minimising applications to go back into the main app tray, were smooth and largely judder-free.

The same can't be said of web browsing performance, though. The tablet tended to stutter when scrolling through complex pages containing lots of images. This is disappointing for such a high-end tablet and its below-average score of 1,356 in Browsermark certainly seemed to back up this impression.

Graphics performance is reasonable. Its score of 17,234 in Basemark X 1.1 on Medium graphics settings shows the Tab S 10.5 should have enough power to run most games in the Google Play Store. However, 3D games may pose a bit of a problem, as shown by poor frame rates of 17.1fps in the Basemark Dunes test and 22.1fps in the Hangar test.

We're amazed that Samsung has managed to squeeze such a huge-resolution AMOLED screen into a £350 tablet. The screen, helped by the clever Active Display technology, is just beautiful, and provides a worthy rival to the iPad Air 2's display. The tablet's performance isn't always what it should be, and we wish Samsung would put this screen on a tablet with a high-end Snapdragon chip, but the Tab S 10.5 is certainly an attractive prospect for those looking for an Android alternative to the iPad Air 2. However, for those after the very best 10in Android tablet, it doesn't get any better than the Sony Xperia Z4 Tablet.



SONY Xperia Z3 Tablet Compact

COMPUTER
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From £279 inc VAT • From www.handtec.co.uk

VERDICT

The Sony Xperia Z3 Tablet Compact is a supremely stylish razor-thin Android tablet with great performance and battery life

SONY'S XPERIA TABLETS have long been among our favourites, but the Xperia Z3 Tablet Compact was the first one to shrink its winning formula to an 8in screen size. We find this size is a good compromise between portability and big-screen entertainment, but some may prefer the 4:3 aspect ratio of an iPad or Google Nexus 9, which can feel more natural when used in portrait mode.

There's no doubt the Z3 Tablet Compact looks great. It's amazingly slim at 6.4mm and weighs just 270g, which is a whole 140g less than the 8in Tesco Hudl 2. More impressively, this tablet is 1.1mm thinner and 60g lighter than the iPad Mini 3. That low weight is easy to appreciate too, as the Z3 is supremely comfortable to hold one-handed due to its super-thin chassis. The frame is made from aluminium, which also helps keep the weight down, while the back is lightly textured soft-touch plastic that's very pleasant to hold.

The Z3's party tricks don't stop at being thin and light. It's also waterproof and dust-resistant, meaning you can safely use it in the bath or to take pictures in freshwater up to 1.5m down for up to 30 minutes at a time. You might want to avoid dropping it in a pool, though, and you'll need to make sure the various slots are sealed before you dive in.

Impressively, Sony has done away with the need for a flap to seal the headphone jack, an orifice likely to have caused many a tablet's watery demise in the past since it's so easy to forget about. There's also a waterproof magnetic charging dock connector on the side, but this does disrupt the Z3 Tablet's otherwise clean lines.

Another of the Z3 Tablet Compact's stand-out features is its 8in 1,920x1,200-resolution display. With a pixel density of 275ppi, images appear incredibly sharp and it's almost impossible to discern individual pixels. More importantly, though, the Z3 has one of the most colour-accurate screens we've tested, as the display is able to produce an astonishing 98.2% of the sRGB colour gamut. This is one of the highest readings we've seen on a tablet, eclipsing the iPad Air 2 and the Google Nexus 9. Although colours are perhaps not as vibrant as they are on the Samsung Galaxy Tab S 8.4, it's still the best LCD screen you'll find before making the jump to one an AMOLED panel.

One advantage the Z3 does have over the Tab S 8.4 is its eye-searing brightness levels, which we measured at a record-breaking 622.10cd/m². Not only does this result in fantastically pure whites, but it also makes the screen very easy to see in bright sunshine.

One downside is slightly higher than average black levels, but our reading of 0.54cd/m² isn't that bad considering the display is so much brighter than everything else we've seen. A contrast ratio figure of 1,104:1 is also impressive, and helped lend an excellent level of detail to our set of test images.

The quad-core 2.5GHz Qualcomm Snapdragon 801 processor feels a little old compared to this year's top-end chipsets, but it's paired with a generous 3GB of RAM, and the tablet still feels responsive in daily use. Apps and menus open swiftly and without delay, and Android feels quick and responsive.

With a score of 1,059 in Basemark OS II, this tablet isn't as fast as the Dell Venue 8 7840 or Google Nexus 9, but it sits comfortably in front of both the Samsung Galaxy Tab S 8.4 and Tesco Hudl 2. Admittedly, its Browsermark score of 1,403 is a little underwhelming, but the Xperia Z3 Tablet Compact never stuttered when loading image-heavy or complex websites, and scrolling and panning were both very smooth.

Where the Z3 hasn't aged is in its gaming performance. Its huge score of 25,585 in our Basemark X 1.1 benchmarks on Medium quality settings equated to a smooth 30.2fps in the Dunes test and 40.3fps in the Hangar test. This surpasses every Android tablet bar the Nexus 9 and Nvidia Shield, both of which are Android gaming champions.

All this power doesn't come at the expense of battery life. In our video playback battery test, with the screen brightness set to our standard 170cd/m², the Xperia Z3 Tablet Compact managed an excellent 13h 8m, which is a full four hours more than we saw on the iPad Mini 3. The Samsung Galaxy Tab S 8.4 just inches ahead with its 13h 54m battery life, but this is still one of the best battery scores we've seen for a tablet of this size.

The tablet's gaming credentials don't stop there. If you own a PlayStation 4 you can also use the Z3 to play PS4 games over your home network using the Remote Play service. This means you can use your PS4 controller to play games all over the house on your tablet, helping avoid arguments over the TV.

The Z3 Tablet Compact comes with Android 4.4 out of the box, but a free over-the-air update to Android 5.0.2 is now available to download. The interface itself has remained largely unchanged, which is a good thing in our books, as we were big fans of Sony's subtle but classy customisations, including its good-looking icons and animated ribbon backgrounds that move as you swipe between app screens. There are still glimpses



of stock Android, including the drop-down notifications menu, but otherwise it's easily one of the most elegant Lollipop-based user interfaces we've seen.

Sony has gone all out with its camera app, as there are plenty of things you can do with its 8-megapixel sensor. Background Defocus, for instance, is designed to replicate the background blur effect from certain DSLR cameras. There's also AR Effect, which uses augmented reality to add in virtual characters such as Spiderman to your shots. They're fun additions, but probably not something you'll likely use once the novelty wears off.

We found the Panoramic Sweep and Manual modes much more useful. Photo quality was good, as the camera was able to capture a decent amount of detail in good light, but images could still be quite grainy and lacking in sharpness in some places. Colours were a little subdued, too.

The Sony Xperia Z3 Tablet Compact is undoubtedly a premium tablet. Its build quality is fantastic, it's razor-thin, making it easy to carry around, and the water- and dust-proofing makes it more practical than its rivals. The addition of PS4 Remote Play alone will be enough to sell it to some, but Android 5.0 means it will keep feeling like a modern tablet longer than its KitKat-only rivals.

When it launched, the Z3 Tablet Compact cost £329, but it has now dropped to £279 for the 16GB version and £310 for 32GB. You can also buy the 16GB version with built-in 4G for £340. The £250 Samsung Galaxy Tab S 8.4 is a fraction cheaper and has a higher-resolution screen, but in our eyes it can't beat the Z3 Tablet Compact for build quality or performance. For this reason, the Xperia Z3 Tablet Compact wins a Recommended award.

SONY Xperia Z4 Tablet

COMPUTER
SHOPPER
RECOMMENDED



£499 inc VAT • From www.sonymobile.com

VERDICT

Expensive, but the gorgeous display, incredible battery life and keyboard make it the ultimate Android slate

JUST WHEN YOU thought tablets couldn't get any more desirable than the iPad Air 2, Sony reveals the Xperia Z4 Tablet, the world's thinnest, lightest 10in Android tablet. Tipping the scales at just 389g, the Xperia Z4 Tablet is a real featherweight, beating Apple's iPad Air 2 by 48g (or 44g if you opt for the 393g 4G model). It's slim, too, measuring a mere 6.1mm, making it one of the most comfortable-to-hold big-screen tablets we've encountered.

Available in black and white, the Xperia Z4 Tablet is a stunning piece of kit. The tablet's soft, textured chassis feels just as luxurious as those of its metallic rivals, and its reinforced nylon corners (to help prevent drop damage) fit snugly in your palm. It's also rated as IP65/68 water- and dust-proof, so you'll be able to submerge it in a metre of water for up to 30 minutes without doing any harm.

The real highlight of the Xperia Z4 Tablet, though, is its 10.1in screen with its massive 2,560x1,600 resolution. This gives it a pixel density of 299ppi, which surpasses the pixel densities of both the iPad Air 2 (264ppi) and Samsung Galaxy Tab S 10.5 (265ppi) by quite a large margin, so everything from your films to your photos should look razor-sharp on its 16:10 display. It's a gorgeous-looking IPS panel that delivers bright, rich and vibrant colours.

Sony's so confident about the quality of its display it says it should hit 130% of the sRGB colour gamut. Our test results weren't quite that high, but a score of 98.3% is still the best we've seen from an LCD display. The only screens that provide even richer colours are Samsung's Super AMOLED panels, as found on the Galaxy Tab S 8.4 and Tab S 10.5.

On a subjective level, we think the Xperia Z4 Tablet has the superior display, as images on the Galaxy Tab S 10.5 had a noticeable orange colour cast when we compared them side by side with the Z4. Sony's display is also brighter, with a massive 463.01cd/m² maximum brightness, which really helps colours pop out of the screen and helps deliver more balanced, natural-looking images. Whites are also very clean, and the contrast level of 1,007:1 leads to plenty of detail.

However, the screen's high brightness levels have a tendency to make blacks look a little grey, and this was backed up with a less impressive 0.45cd/m² black level. Still, on balance this is still the best tablet display we've seen, and we much prefer it to both the iPad Air 2 and Galaxy Tab S 10.5's screens.

Unfortunately, as our review sample was an early production model, we weren't able to run any of our normal performance benchmarks on the Z4 Tablet. However, its

octa-core 2GHz Qualcomm Snapdragon 810 processor is the same chipset that you'll find in most flagship smartphones this year such as the HTC One M9, so it certainly won't be lacking for speed. For instance, Android 5.0 Lollipop felt lightning-fast as we swiped through its various home and menu screens, and apps loaded in an instant.

We were able to run our Browsermark and Basemark X 1.1 tests to assess web-browsing and graphics performance. In Browsermark, the tablet scored a huge 2,044, which is just behind the Google Nexus 9. In practice, we could barely tell the difference when scrolling up and down web pages, as both tablets felt equally smooth and responsive.

Google's tablet was also ahead in our Basemark X 1.1 tests, but the Xperia Z4 Tablet's score of 32,659 (which averaged out as 34fps in the Dunes test and 35.8fps in the Hangar test) is still pretty impressive considering the GPU inside the Nexus 9's Nvidia Tegra K1 processor is arguably the most advanced mobile chip currently available. Otherwise, the only tablet that even comes close to matching the Z4 Tablet's gaming performance is the iPad Air 2, which only scored 26,285 overall in the same test.

Crammed inside the Z4's tiny chassis is a huge 6,000mAh battery. Sony says this should last for up to 17 hours of video playback when using its Stamina energy saving profile, but even with this disabled, we managed an astonishing 19h 48m with the screen set to our standard 170cd/m² brightness. This is incredible for such a slim tablet, and it's by far and away the best battery score we've ever seen from any tablet, regardless of size, making it the ultimate companion for work and play alike.

Having enough battery life to work on the move is important, as the Xperia Z4 Tablet is being bundled with Sony's new Bluetooth keyboard dock, the BKB50. Obviously, Android doesn't offer the same kind of flexibility as Windows, but Sony has implemented a few clever tricks in its version of Android 5.0 Lollipop to help transform the OS into a viable desktop platform.



For instance, attaching the keyboard dock, which slots securely on to the tablet's lower bezel, will prompt an additional row of customisable app shortcut icons to appear in the bottom corner of the screen in a similar style to the current Windows 7 and Windows 8.1 taskbar, giving you easy access to your favourite apps with the touchpad. You can also use the touchpad to scroll through the taskbar to access different apps or swipe between home screens, although we found the swiping action was a bit temperamental.

The keys themselves are a little cramped, so if you have large hands you may well end up pressing more than one key as you type. It's certainly no Surface Type Cover keyboard, which is available for the Microsoft Surface 3, but the keys provide a good level of tactile feedback, and Sony has included several Android-specific keys to help make navigating the tablet that bit simpler. However, the mouse cursor was often quite sluggish when it first sprung into life and, like most Bluetooth docks, it tended to turn itself off quite quickly if we didn't use it for a couple of minutes, forcing us to tap a key and wait for a few seconds before the cursor reappeared.

On the back is an 8.1-megapixel camera, which uses Sony's Exmor RS mobile sensor. On the whole we were very pleased with the images we took, as colours were bright and natural and there was a good level of detail on show. When we zoomed in, however, we could see some obvious signs of noise-reduction and very busy areas weren't quite as sharp as we would have liked.

With so many strings to its bow, the Sony Xperia Z4 Tablet is one of the best tablets we've seen. Its stylish design continues the legacy of predecessors, and its new desktop capabilities, high-resolution screen and industry-leading battery life blow the rest of the competition out of the water. It is very expensive and the keyboard dock could be a bit more polished, but if you're after the ultimate Android tablet, there's nothing else like it. It wins a Recommended award.

TESCO Hudl 2

COMPUTER SHOPPER
BEST BUY

★★★★★

£99 inc VAT • From www.tesco.com

VERDICT

The Hudl 2 is a thoroughly grown-up tablet that's now even better value than ever

THE TESCO HUDL 2 continues to be the best budget Android tablet you can buy today. Despite there being no news on when it will be updated to Android 5.0 Lollipop, the Hudl 2 still outperforms every other budget tablet we've managed to get our hands on – and it's now even cheaper at an astounding £99.

Version 2 is a huge improvement on the original Tesco Hudl: it's now bigger, faster, has a higher-resolution screen and is even more of a bargain than before. The first thing you notice is the tablet's size. The Hudl 2 is an 8in tablet compared to its 7in predecessor. We're seeing an increasing number of 8in tablets, which we think are a particularly good compromise between overall tablet size and having a screen big enough to do most of the things you would on your laptop.

The Hudl 2's 8in display has a 1,920x1,200 resolution, putting it comfortably above other budget tablets which are still stuck with 1,280x800 resolutions, such as the Acer Iconia One 7. This gives the whole screen a much sharper, more defined appearance and makes it feel like a far more expensive tablet.

Considering the tablet's price, it's a pretty decent display, too. While not quite as accurate as the Iconia One 7's screen, our colour calibrator tests showed the Hudl 2 was displaying 79.4% of the sRGB colour gamut and had a contrast ratio of 1,062:1, which is more than can be said of other budget tablets such as the Vodafone Tab prime 6.

Black levels were also deep at 0.31cd/m², and the tablet's high peak brightness of 373.39cd/m² helps it produce very pure, clean whites. The screen will dim slightly when you're not looking at it face on, but on the whole we were impressed with its bright, vivid colour reproduction.

The Hudl 2's chassis is another area where it punches above its price. The tablet is lovely to hold, with soft-touch plastic wrapping round the rear and sides. The slim bezels at the top and bottom of the screen are offset by chunkier ones at the sides, but these help give the Hudl 2 a balanced look. They also give you somewhere to rest your thumbs when holding the tablet in landscape mode.

Around the edges you'll find a microSD card slot, which you'll probably need as the tablet has only around 9GB of its 16GB storage left out of the box, and a Micro HDMI port to plug it into your TV. Tesco has made a fairly big fuss about the tablet's stereo speakers and, while they have a fair amount of stereo separation and are fine for watching a bit of on-demand TV, you shouldn't expect them to flatter your music much.



Tesco has largely left Android 4.4.2 alone, but its custom launcher has nicer fonts and a transparent background for the app tray compared to stock Android. This custom launcher also gives you easy access to Tesco's own widgets (you're asked if you want to sign in to your Tesco account as well as Google when you first turn on the tablet), showing information such as Clubcard points, your nearest Tesco and new recipes. You can delete them if they prove too bothersome, but you may find them useful if you're a regular Tesco shopper. The one thing we didn't like about the Tesco launcher was the jerky animation when flicking to the Tesco widgets page.

Tesco has also added its own custom apps. The first two are a friendly introduction to the world of Android, which the less tech-savvy Tesco shopper may appreciate. 'Get started' takes you through how to use your tablet, and 'Top apps' gives you Tesco's pick of the Google Play store, divided into categories such as Movies, Music, Reading, Gaming and so on. Both apps are well designed and look great; the Hudl 2 certainly feels like a professionally put together piece of kit.

The Hudl 2 feels tough enough to give to your kids, and families will appreciate the Child Safety app. This lets you add profiles for up to seven members of your family, and set the web pages they can view, the apps they can use and when they can use the tablet, and for how long. The software asks for each child's age and sets defaults accordingly, and altering each child's profile is simple.

The original Hudl's 3.2-megapixel camera was poor, and the Hudl 2's 5-megapixel sensor isn't great, either. Images look low-resolution with little detail; it's the most obvious place where costs have been cut. Still, a camera is arguably less important on a tablet than a smartphone, so we can forgive this flaw, particularly on such an inexpensive tablet.

The Hudl 2 has a quad-core Bay Trail Intel Atom Z3735D processor running at 1.33GHz and comes with 2GB of RAM. It did fairly well in our benchmarks, completing our Basemark OS II test with an overall score of 904. This puts it just behind the £150 Asus MeMO Pad 7 ME572C's score of 1,073, and in actual use, the tablet is pretty quick. There's some very

mild lag when opening and closing the app tray, but the Hudl 2's performance is absolutely fine considering its low price.

Web browsing is pretty smooth, and the tablet scored a strong 1,615 in our Browsermark test. We noticed a bit of delay when browsing complicated web pages on *The Guardian* site with nested comments, but general scrolling showed no sign of stutter and zooming in was very smooth.

The Hudl 2 isn't bad for playing games, but it will struggle with particularly challenging 3D titles. It managed 11,530 in our Basemark X 1.1 graphics test on Medium quality settings, but this only translated to an average frame rate of 13.7fps in the Dunes test and 17.8fps in the Hangar test. The best tablets such as the Nexus 9 score nearer 40,000, but you should still be able to play less demanding 2D titles on the Hudl 2 and even a bit of office favourite *Hearthstone* if you can put up with the slightly jerky animations.

The Hudl 2's only major flaw is its battery life. The tablet managed 6h 58m of continuous video playback when we set the screen to our standard 170cd/m², which is definitely below average and far behind the 9h 35m we saw from the original Hudl. If you're after a tablet to take on long journeys, this probably isn't the model for you, and you'll need to be prepared to charge it every night, especially if your entire family wants a go.

We liked the original Hudl, which we considered basic but great value. The Hudl 2 is a vast improvement. We like the tablet's design, screen and parental control software, and although it isn't a spectacular performer, it's quick enough. The only disappointment is the battery life, making this more a tablet for the home than for travelling. If battery life is important to you you're better off saving up another £50 for the Asus MeMO Pad 7 ME572C. However, for £99, there's just nothing that can touch the Hudl 2, and if you're a savvy Tesco Clubcard user you don't even need to pay anything at all, as Tesco's Clubcard Boost lets you turn every £5 of Clubcard vouchers into £10 off the tablet. The Hudl 2 is a massive bargain, and a Best Buy.

VODAFONE Tab prime 6



£150 inc VAT • From www.vodafone.co.uk

VERDICT

The Vodafone Tab prime 6 is a well-made tablet, but its poor screen and sluggish performance make it one to avoid

IT'S NOT STRICTLY necessary to have a tablet with built-in 4G if you want to get online away from a Wi-Fi hotspot, as depending on your mobile contract you can simply use your phone as a wireless hotspot. However, there's little to beat the convenience of having wireless data built into your tablet, and the Vodafone Tab prime 6 is a pretty cheap way to get it.

At least it is if you buy one on Vodafone's Pay As You Go service, where the tablet costs just £150 and you can top up with 30-day data allowances when you need them. Go for a Pay Monthly option and the cost quickly begins to rise, as prices start at £17 a month for 1GB of 4G data with an up-front cost of £19 for the tablet, and go all the way up to £31 a month for 8GB of data with no up-front cost. This can make the total cost of ownership as high as £744 over two years, which makes it considerably more expensive than your average Wi-Fi only Android tablet.

The Tab prime 6 is just 7.9mm thick and weighs 406g, and feels reasonably well made. We're big fans of its soft-touch rear, as this makes it easy to hold for long periods, and its gently rounded corners are comfortable in the hand. The tablet also comes with Android 5.0 Lollipop straight out of the box, and its stock version of Google's latest operating system looks cleaner and has a more modern appearance than the operating systems on many of its Android KitKat-based rivals.

By modern standards, there simply aren't enough pixels here to deliver a crisp, clean image

However, that's more or less where the Tab prime 6's appeal ends. Its 9.6in 1,280x800 screen is very disappointing. By modern standards, there simply aren't enough pixels here to deliver a crisp, clean image, and its pixel density of just 157ppi means that icons and text are visibly blurry and pixellated. This combination probably wouldn't have been that unusual a couple of years ago, but when 1,280x720 resolutions are now the norm for decent budget smartphones such as the £150 Motorola Moto G (whose 5in screen gives it a pixel density of 294ppi), stretching a similar resolution across a screen four times the size just doesn't cut it.

It doesn't help that the tablet's IPS panel looks a pretty cheap one, as it not only has a grainy finish, making it even harder to see the screen clearly, but its colour accuracy is also

one of the worst we've seen. The display covers just 58.5% of the sRGB colour gamut, and looks very washed out; colours have little sense of depth or vibrancy. The graph produced by our colour calibrator showed that greens were perhaps its strongest area, but all the major primary colours fell short of the sRGB gamut boundaries, so photos and videos will never look their best.

It doesn't help that the screen isn't that bright; we measured a peak white level of just 275.18cd/m². This is fine for indoor use, but you'll struggle to see the screen clearly in sunlight, and dark scenes in particular proved almost impossible to see when we watched a film on the train. Contrast is also average at 750:1, but at least the screen's reasonable black levels of 0.37cd/m² are more in line with what we'd expect from a £150 tablet.

Another area where the Tab prime 6 falls down is in its day-to-day performance. Its quad-core 1.2GHz Qualcomm Snapdragon 410 processor is no faster than a typical budget smartphone's, and its score of 525 in Basemark OS II is almost half what the Tesco Hudl 2 managed. Likewise, its score of 1,128 in Browsermark is low, and web browsing could be noticeably juddery; image-heavy pages such as *The Guardian* often stuttered when scrolling, and articles with embedded videos proved particularly troublesome.

This isn't a tablet you'll be rushing to play 3D games on, either, as it scored just 4,022 in

our Basemark X 1.1 graphics benchmarks, averaging a measly 6.8fps in the Dunes test on Medium quality settings and 10.6fps in the Hangar test. It also failed to complete either test in High quality, as it crashed repeatedly whenever we tried to run them. The tablet can run simple 2D games perfectly well, and we were even able to play a game of *Hearthstone* despite its somewhat jerky animations.

One redeeming feature is its battery life. With a 4,600mAh battery on board, the tablet managed a respectable 8h 44m in our continuous video playback test with the screen set to 170cd/m², which should be more than enough to keep even the most ardent film streamers satisfied during long journeys.

If you'd rather keep your media files on the tablet itself, the 16GB of onboard storage should be enough to get you started. It's a



shame the microSD card slot only supports cards up to 32GB, but this is fairly standard across most tablets at this price.

As a Vodafone tablet, it naturally comes pre-loaded with a couple of Vodafone apps, but thankfully most of them are hidden away in the app tray. We'd recommend getting rid of the Discover widget, but it's worth installing the Vodafone Net Perform app, as this lets you monitor your data usage and test network speeds. My Vodafone is another key app for Vodafone mobile customers, as this lets you check the number of minutes, texts and data you've used if you're on a pay monthly contract, or your remaining credit and Freebies if you're on prepay.

On the rear of the tablet is a 5-megapixel camera. It's a token addition, and hardly the highlight of the tablet, but we don't think you'll be using it very often anyway. Colours and shadows were often a little green in places and several areas of detail only showed muddy clumps of blurred pixels. HDR mode was even worse, as instead of correcting each picture's contrast level, it looked as though the camera had simply applied a grey filter to each picture, making images look even duller than before.

If you buy it on prepay, Vodafone's Tab prime 6 is one of the cheapest large-screen tablets there is, and is especially cheap for a model with built-in 4G. However, its low price shows in the tablet's screen and performance. We'd rather use a phone as a Wi-Fi hotspot and buy a cheaper, smaller tablet such as the Tesco Hudl 2 or Asus MeMO Pad 7 ME572C, or save up for a better, larger model such as the Google Nexus 9.

		RECOMMENDED		RECOMMENDED		RECOMMENDED	BEST BUY	
	ACER	APPLE	APPLE	ASUS	ASUS	DELL	GOOGLE	
	Iconia One 7 B1-750	iPad Air 2	iPad Mini 3	MeMO Pad 7 ME572C	Transformer Book T100 Chi	Venue 8 7840	Nexus 9	
	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	

Hardware

Processor	Quad-core 1.33GHz Intel Atom Z3735G	Tri-core 1.5GHz Apple A8X	Dual-core 1.3GHz Apple A7	Quad-core 1.83GHz Intel Atom Z3560	Quad-core 1.46GHz Intel Atom Z3775	Quad-core 2.33GHz Intel Atom Z3580	Dual-core 2.3GHz 64-bit Nvidia Tegra K1 Denver	
RAM	1GB	2GB	1GB	2GB	2GB	2GB	2GB	
Screen size	7in	9.7in	7.9in	7in	10.1in	8.4in	8.9in	
Screen resolution	1,280x800	2,048x1,536	2,048x1,536	1,920x1,200	1,920x1,200	2,560x1,600	2,048x1,536	
Screen type	LCD	IPS	IPS	IPS	IPS	AMOLED	IPS	
Front camera	0.3 megapixels	1.2 megapixels	1.2 megapixels	2 megapixels	2 megapixels	2 megapixels	1.6 megapixels	
Rear camera	5 megapixels	8 megapixels	5 megapixels	5 megapixels	5 megapixels	8 megapixels	8 megapixels	
Flash	No	No	No	No	No	No	Yes	
GPS	Yes	Yes (Wi-Fi + Cellular only)	Yes (Wi-Fi + Cellular only)	Yes	No	Yes	Yes	
Compass	Yes	Yes (Wi-Fi + Cellular only)	Yes (Wi-Fi + Cellular only)	Yes	No	Yes	Yes	
Storage	16GB	16/64/128GB	16/64/128GB	16GB	64GB	16GB	16/32GB	
Memory card slot	MicroSDHC	None	None	MicroSDXC	MicroSDXC	MicroSDXC	None	
Wi-Fi	802.11n	802.11ac	802.11n	802.11n	802.11n	802.11ac	802.11ac	
Bluetooth	Bluetooth 4.0	Bluetooth 4.0	Bluetooth 4.0	Bluetooth 4.0	Bluetooth 4.0	Bluetooth 4.0	Bluetooth 4.1	
NFC	No	No	No	No	No	No	Yes	
Wireless data	None	4G +£100	4G +£100	None	None	None	4G +£60 (32GB)	
Size	193x114x 8.6mm	240x169.5x 6.1mm	200x135x 7.5mm	114x200x 8.3mm	265x175x 14.8mm	216x124x 6.1mm	154x228x 7.9mm	
Weight	320g	437g	331g	269g	570g, 1.1kg with keyboard	305g	425g	

Features

Operating system	Android 4.4	iOS 8.1	iOS 8.1	Android 5.0	Windows 8.1	Android 4.4	Android 5.1	
Battery size	3,420mAh	7,340mAh	6,471mAh	Not disclosed	Not disclosed	5,670mAh	6,700mAh	

Buying information

Warranty	One year RTB	One year RTB	One year RTB	One year RTB	One year RTB	One year collect and return	One year RTB	
Price inc VAT	£80	From £399	From £319	£150	£400	£369	From £290	
Supplier	www.argos.co.uk	store.apple.com/uk	store.apple.com/uk	www.johnlewis.com	www.pcworld.co.uk	www.dell.co.uk	www.expansys.com	
Details	www.acer.co.uk	www.apple.com/uk	www.apple.com/uk	www.asus.com	www.asus.com	www.dell.co.uk	www.google.co.uk/nexus/9	
Part code	NT.L65EE.001	Apple iPad Air	Apple iPad Mini 3	ME572C	T100CHI-FG007B	CNV8701	99HZF008-00	

RECOMMENDED		RECOMMENDED	RECOMMENDED	RECOMMENDED	BEST BUY	
MICROSOFT	SAMSUNG	SAMSUNG	SONY	SONY	TESCO	VODAFONE
Surface 3	Galaxy Tab S 8.4	Galaxy Tab S 10.5	Xperia Z3 Tablet Compact	Xperia Z4 Tablet	Hudl 2	Tab prime 6
★★★★★	★★★★☆	★★★★☆	★★★★★	★★★★★	★★★★★	★★★★☆
Quad-core 1.6GHz Intel Atom X7-Z8700	Quad-core 1.9GHz Samsung Exynos 5 Octa (+quad-core 1.3GHz)	Quad-core 1.9GHz Samsung Exynos 5 Octa (+quad-core 1.3GHz)	Quad-core 2.5GHz Qualcomm Snapdragon 801	Octa-core 2GHz Qualcomm Snapdragon 810	Quad-core 1.33GHz Intel Atom Z3735D	Quad-core 1.2GHz Qualcomm Snapdragon 410
4GB	3GB	3GB	3GB	3GB	2GB	1GB
10.8in	8.4in	10.5in	8in	10.1in	8.3in	9.6in
1,920x1,280	2,560x1,600	2,560x1,080	1,920x1,200	2,560x1,600	1,920x1,200	1,280x800
IPS	Super AMOLED	Super AMOLED	IPS	IPS	IPS	IPS
3.5 megapixels	2.1 megapixels	2.1 megapixels	2.2 megapixels	5.1 megapixels	1.2 megapixels	2 megapixels
8 megapixels	8 megapixels	8 megapixels	8.1 megapixels	8.1 megapixels	5 megapixels	5 megapixels
No	Yes	Yes	No	Yes	No	No
No	Yes	Yes	Yes	Yes	Yes	Yes
No	Yes	Yes	Yes	Yes	Yes	Yes
128GB	16GB	16GB	16/32GB	32GB	16GB	16GB
MicroSD	MicroSDXC	MicroSDXC	MicroSDXC	MicroSDXC	MicroSDHC	MicroSDHC
802.11ac	802.11ac	802.11ac	802.11ac	802.11ac	802.11n	802.11n
Bluetooth 4.0	Bluetooth 4.0	Bluetooth 4.0	Bluetooth 4.0	Bluetooth 4.1	Bluetooth 4.0	Bluetooth 4.0
No	Yes	No	Yes	Yes	No	No
4G (price TBC)	4G +£89	4G +£120	4G +£76	4G +£80	None	4G
187x267x 8.7mm	213x126x 6.6mm	247x177x 6.6mm	213.3x123.6x 6.4mm	167x254x 6.1mm	224x128x 9mm	146x244x 7.9mm
622g	294g	465g	270g	389g	410g	406g
Windows 8.1 (64-bit)	Android 5.0	Android 4.4.2	Android 5.0	Android 5.0	Android 4.4	Android 5.0
Not disclosed	4,900mAh	7,900mAh	4,500mAh	6,000mAh	Not disclosed	4,600mAh
One year RTB	One year RTB	One year RTB	One year RTB	One year RTB	One year RTB	One year RTB
£499	£250	£350	From £279	£499	£99	£150 (Pay As You Go)
www.microsoftstore.com	www.currys.co.uk	www.currys.co.uk	www.handtec.co.uk	www.sonymobile.com	www.tesco.com/direct/hudl	www.vodafone.co.uk
www.microsoft.com	www.samsung.com/uk	www.samsung.com/uk	www.sony.co.uk	www.sonymobile.com	www.tesco.com/direct/hudl	www.vodafone.co.uk
Surface 3 – 128GB	SM-T700	SM-T800	SGP621GB	Xperia Z4	hudl2	Tab Prime 6

Prices correct at time of going to press





Virtually Real

The digital world of computing is colliding with physical reality, thanks to augmented reality, 3D cameras, haptic feedback and more. **Nicole Kobie** reveals what it means for the future of your laptop

Although computers have changed our world immeasurably, the relationship between what happens in the virtual and the real worlds remains stark. That divide is starting to be eroded, though. Soon our PCs will populate our homes with virtual objects; we'll be able to reach inside virtual spaces to manipulate digital objects; and your PC will even respond by reaching out and touching you back.

Gesture recognition and haptic feedback, 3D cameras and scanners, and augmented reality are blurring the lines between the digital world and the physical one. Soon, instead of sitting at a laptop with a keyboard and touchpad, you'll be using natural gestures seen with 3D cameras to interact with your computer, with the results overlaid on the physical world thanks to augmented reality (AR).

The forerunners of AR technology are already here; take Google Glass or Microsoft's exciting new HoloLens technology for starters. These are the very opposite of virtual reality: where VR transports you to a virtual world, AR brings the virtual into our world. It's not all about headsets, though, with new ways to interact with screen-based computers being the more immediate future.

Gesture recognition

Professor Sriram Subramanian, co-director of the interaction and graphics group at the University of Bristol, says we're all used to the collision between us and our computers happening via a keyboard and a mouse, and seeing the result on a monitor. "What we call a computer is changing as well," he

said. "People want to be able to input in a much more expressive way, and that's the key."

Typing may feel natural for those of us who have been doing it for years, but it's not how we instinctively communicate. Gestures, on the other hand, are natural; Subramanian points out that he can't keep his hands from moving as he answers our questions. "I'm gesticulating as we speak, and this is something that people want to be able to do when they interact with a computer," he said. "I think this is where we're going towards."

Gesture recognition isn't new. Microsoft's Kinect brought it to the mainstream in 2010, giving first your Xbox and then your PC a set of eyes that could better see the world. It was quickly hacked – in a good way – for uses far beyond entertainment, including to be used by surgeons to interact with a computer without using their hands mid-operation and for 3D designers to manipulate objects.

The idea took another step forward with Leap Motion, a similar technology that's been built into HP laptops. As with Kinect, it works by tracking your fingers, letting you not only bat away bad guys in games, but also navigate through Windows.

Leap Motion was a clever idea with one downside: its first iterations didn't work all that well. One of the problems with gestures is you don't know if they're working: you end up waving your hands about, staring at the screen as you hope the camera is capturing your movement in the right way. The benefit of physical buttons is they offer feedback; it's why your smartphone vibrates slightly when you tap a virtual key, and why the



best keyboards have a bit of 'travel', moving under your fingers so you know your finger press has been recognised.

Subramanian pointed out that touch has been largely forgotten about by gesture recognition designers. As the physical and digital worlds collide, touch can help make that interaction even smoother. He and his team of researchers are working to mimic the response of the physical world in gestures, letting your computer reach out and touch you via ultrasound waves – what's been dubbed 'ultrahaptics'.

"If you're playing with a Kinect at home and you're playing a game of volleyball or tennis, right now you hit the ball and you have no feedback," Subramanian said. "You can see onscreen that you've hit the ball but you don't feel it... It's important to be able to feel content."

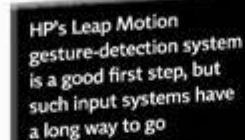
That's the same problem faced by Leap Motion laptops, such as the HP Envy 19, he said. "The market uptake for such laptops has not been so big because they [users] miss the tactile feedback," he said.

Soon, your PC will be able to give you that feedback, applying pressure to your hand with ultrasound. Subramanian's lab has come up with the idea for ultrahaptics, which uses arrays of ultrasound speakers to focus sound pressure on your hand in response to your gestures, giving you something solid to feel in mid-air. The ultrasound can be modulated so it feels like a vibration on your skin – similar to smartphone screens – or different 'sound' textures.

Using an array of 16 ultrasound speakers, it's possible to feel the pressure at a distance of 20m. Subramanian's team has already successfully run simulations using the Kinect.

Sprouting out in 3D

3D printers mean we can output from our computer to the real world – but it also works in reverse. The advent of 3D cameras and scanners, which incorporate depth as well as standard imaging, means we can capture real-world objects.



HP's Leap Motion gesture-detection system is a good first step, but such input systems have a long way to go

Take the HP Sprout. This odd-looking all-in-one PC features an overhead unit called the 'Sprout Illuminator'. It's a projection and capture system that works in combination with a soft, touch-sensitive mat that sits in front of the Sprout's screen. There's a lot of technology packaged into the Illuminator, including a depth sensor, 14.6-megapixel camera, scanner and the projector that creates a second display on the mat.

That means it can see your fingers for gesture recognition, and can also scan real-world objects in two or three dimensions, pulling them into your computer to be digitally manipulated. HP showed off scanning in alphabet blocks and other children's toys, and using them in a digital photo scrapbook.

You can scan 3D objects in less than a minute, with the Sprout's camera displaying patterns on your object of choice to help improve the camera's depth perception. However, finely detailed items will take longer to scan, and to get all the bits and pieces you may have to stitch together multiple scans. In other words, you can't yet scan a household item and then immediately send it to a 3D printer, but as the technology improves the future seems increasingly likely.

sensor with an infrared one and a micro-electronic device that projects an invisible pattern across objects to help measure depth. There's also a specialised chip that runs firmware to analyse the results.

RealSense can be built into the rear of a tablet or in place of a laptop or desktop webcam, adding an extra dimension to computer vision. Naturally, it has potential for gaming, but Intel has also shown it off for photography. The extra depth data makes it easier to edit images: you can drop colour out of the background, blur it artfully, or even slightly adjust the focal point after shooting. The extra data also means RealSense can measure photographed objects. Take a snap of your living room, tap each edge of your sofa, and it will tell you the size. Intel also suggests using it with VoIP, as it can use its depth perception to blank out the background, so that you're clearly the subject and not your messy home or office.

The potential of RealSense is clear, and its low additional cost should see it land in more devices in the coming years. However, like the Sprout, Leap Motion and Kinect before it, the actual experience is variable. With some photos, it works perfectly; with others, it's rather off. The measuring tool in particular is problematic: it accurately measured the size of a copy of *Computer Shopper*, but misjudged other items as feet rather than inches. A measuring tape that isn't reliable is pointless. The photography edits were also variable; in just the right light, conditions and with enough distance between foreground objects and the background, you can achieve the results shown off in its tutorials, but our initial attempts on a vase of flowers failed to work as cleanly as hoped.

Simon Lambden, user experience engineer at Intel, admitted the technology is on "the initial curve", and it depends on software and applications being developed for it to truly shine. Indeed, for the Dell Venue 8 7000 Series tablet we used (see page 85), there are only the photography and measuring apps available; no others can be downloaded yet.

Sense of reality

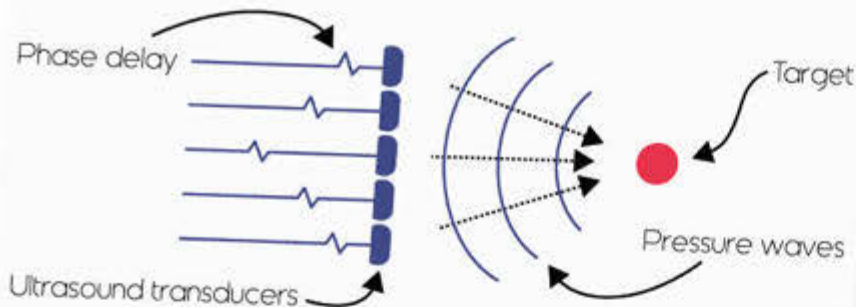
The HP Sprout is a specialised device that will set you back £1,899, but you don't need to shell out so much to get an integrated 3D camera: you can use the one at the heart of Sprout for much less. That's Intel's RealSense 3D camera, revealed at last year's Intel Developer Forum in San Francisco, where the chipmaker promised that it will add little to the price of a device.

RealSense combines a standard CMOS camera



This Kinect-powered interactive media wall at Boston Children's Hospital is designed to give sick children a sense of empowerment by responding to even small motions in grand ways

Ultrahaptics



"There isn't a screen to touch or a mouse to click," the company explained. "Microsoft HoloLens understands your movements, vision and voice, enabling you to interact with content and information in the most natural way possible."

As it works with the next version of Windows, it won't only be used for immersive entertainment and gaming, but for day-to-day computing tasks. Microsoft used HoloLens to navigate through Windows 10, using gesture recognition to swipe and tap

at AR images overlaid on your view. It's the ultimate collision of reality and digital worlds, with Microsoft also showing off a helper app that shows users how to install a light bulb by overlaying the instructions on the real world.

It's powered by what Microsoft calls a "next-generation built-in high-end CPU and GPU". However, the company said it needed a third 'holographic' processor as well in order for the device to truly understand the world around us, so it created the Holographic

Processing Unit (HPU), which can understand what you're doing, where you're looking, your gestures, your voice and the ability to spatially map the world around us. It can also supposedly process terabytes of data in real time, all without wires and external cameras.

➔ The HP Sprout shows how combining the latest technology into one unit can create something that's far more than just a PC



headset may look like the stuff of science fiction, but Microsoft is promising to deliver it within the lifespan of Windows 10 – though how long that will be is under some debate.

At the launch, Microsoft developer Alex Kipman said HoloLens was the "first fully untethered holographic computer".

"We feel that it does offer great user experiences today, but within the future obviously the software improves and new user models appear," said Lambden.

What makes all of this possible is the extra processing power in modern computers, Lambden said, saying the RealSense work started from a point of considering what to do with the excess 'horse power' inside the CPU.

Intel says it's impossible to predict how developers will use RealSense. "We don't know what's around the corner, but someone else can find another use for this technology," Lambden said. He pointed to one game called Nevermind, a horror-themed experience that uses the infrared aspect of the camera to check your pulse while you play, so it can tell if you're scared or not. "It can work out whether you're sad, happy or surprised," Lambden explained.

Another potential use is security. Facial recognition systems can be fooled with a flat image – RealSense would in theory be harder to fool. "It's another metric to work out who you are," said Lambden. "If you've got a 3D camera, certainly you need a 3D model for that person to log in, right? Because it can see, 'oh that's flat; that's not a real person.'"

Of course, a 3D camera can also be used for gesture recognition, and the added dimension helps it determine individual fingers and let you tip and rotate your hand. "It can still track your fingers, which is something a 2D camera can't do, because as soon as your fingertips are intruded by the back of your hand, you no longer know where your fingers are," said Lambden. It will help make computing "more interactive, more natural", he added.

Augmented reality

Computing will fully integrate with reality when computers disappear – and Microsoft's HoloLens certainly makes them fade from view. HoloLens was a surprise from Microsoft, which unveiled the holographic computing headset as part of its marketing push for Windows 10. The augmented reality

Mind-reading machines

The ultimate collision between computers and reality will be when they can read our minds – and for some small aspects that's already possible, says Professor Sriram Subramanian of the University of Bristol.

"You can certainly wear a brain computer headset and you can think of a specific action that can be controlled by the computer or the system," he explained. "But to be able to imagine you want to lift a cup and the cup lifts or imagine to move a cursor, that's going to take some time."

"We are able to detect specific signals that the brain sends out," he said. "Let's say, for example, you're going down the road and GPS tells you turn left, then turn right and you're confused because you've been [that way] and you don't think that that's what you should do. And then your brain sends a signal, and those kinds of things we can detect."

Another example is looking for mistakes: if you think "Oh, I shouldn't have done that", the computer could instantly undo it. "It's called an event-related potential," he said. "The great thing about that is that I can be wearing this headset and if I'm watching you perform an activity and I think you're making a mistake that signal can be detected."

But, as with the other technologies here, while such electroencephalography (EEG) scanning has "interesting possibilities", Subramanian said more innovation is needed before we'll see it in consumer devices.





Further demos at Microsoft's recent BUILD conference wowed us even further. The most outlandish demonstration showcased what Microsoft described as "mixed reality" – a conventional robot that has a friendly avatar hovering above it when you're wearing the HoloLens. The avatar doesn't just give the basic robot a more human-like persona, it allows the HoloLens wearer to control the robot's functions.

The presenter used voice commands to tell the robot's avatar to 'wake up', at which point a Metal Mickey-like animation appears to emerge from the robot and float above the device, as if it's physically attached.

Microsoft demonstrated how the robot can tap into the headset's 3D mapping facilities to help navigate its way around the stage. The HoloLens-wearing presenter could reach out and tap to the points on the stage where she wanted the robot to move to. If an obstruction was placed in its path – in this case another presenter – the robot could plot a path around the obstruction.

The next demo was set around a fake living room, where the user had placed numerous tiles and widgets on various pieces

of furniture or pinned to the wall. A 3D representation of a cartoon Hawaiian beach was providing real-time weather updates from the island for an upcoming holiday, while a Skype window full of profile pics of close friends was pinned to the wall, in order to encourage the user to keep in contact. A large calendar was sitting upright on a dresser.

On the wall was an entertainment screen, a media player basically, which was playing movie trailers. The demonstrator simply commanded the screen to follow him, and it floated after him as he walked around the 'house' before he pinned it back to another wall and supersized it with a simple gesture.

However, like all the other technologies discussed here, it remains early days for the HoloLens. The view through the headset is currently limited, covering only the area directly ahead, with no peripheral vision. This means virtual elements seemingly pop into view as you turn towards them. The headset can track where you're pointing your head at present, but not where your eyes are looking precisely. The headset is also still bulky, so that wearing it most of the time isn't practical, and battery life is still unknown.

Making the leap

HoloLens is easily the most obvious contender in the Augmented Reality space, but it's not the only one. Magic Leap is a far more mysterious company, about as far from Microsoft as it's possible to be in terms of exposure. However, that doesn't mean it shouldn't be taken seriously; the company has already secured \$500m of venture funding from companies including Google and smartphone chipset-manufacturer Qualcomm. It also has some top talent onboard, and a very smart-looking promotional video made in collaboration with special effects company Weta Workshop, the company behind *The Hobbit* and *The Lord of the Rings* films.

Magic Leap is very secretive, but is reportedly working on head-mounted devices that project a light field directly into the eye. We've seen light field technology before, from the capture end, in the form of Lytro's light field camera. That device could capture the light from an entire scene, allowing the user to move the focus point after the picture was taken. Using light fields projected into the eye would create a similar effect,

generating a true 3D image on the retina that the wearer could then focus upon naturally.

Such a headset could be amazing for Augmented Reality, letting you focus on your surroundings and the virtual objects in a very natural manner. How this compares to Microsoft's HoloLens is unknown, as no-one outside those companies has tried either, let alone both. However, the ease with which we will be able to see this brave new world will be critical to its acceptance.

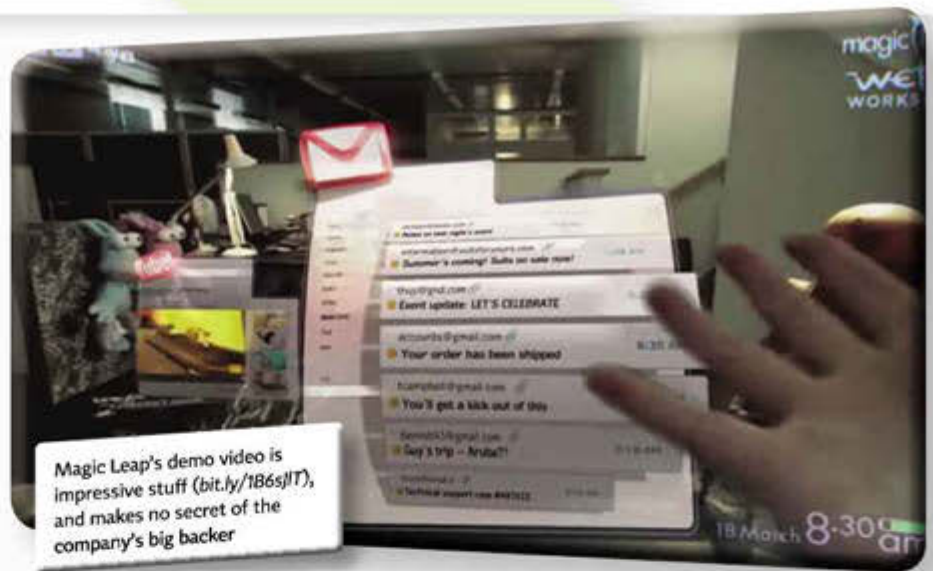
What your PC will look like

None of these technologies is ready for mainstream computing, but they show the road down which it's moving – one that further blurs the line between physical reality and computing.

However, IHS iSuppli analyst Rhoda Alexander says it's difficult to tell how much demand there is for such features. "It's still early days on these products and there are a lot of variables besides this feature in a PC purchase, so it's difficult to gauge consumer response," she said. "There is definite interest and for some of those consumers it is going to tip their buying decision towards a product that incorporates this capability."

Gestures and augmented reality keyboards won't be replacing the peripherals that live on your desk any time soon, Alexander added, but new technologies are reducing our reliance on the mouse and keyboard. "While it [gesture] adds to the experience and allows the consumer to initiate some specific commands and engage with the screen in a different way, it currently lacks the precision and speed that users are accustomed to experiencing through the mouse and keyboard," she said. "However, when you consider gesture in the larger context of expanded inputs – touch, voice, gesture – and the growing suite of apps that use these technologies, user dependence on keyboard and mouse alone is decreasing."

But innovation happens fast. Alexander predicted that over the next decade the laptop will evolve into something entirely



different, and more personal. "If you think about a smartphone, it's essentially a mobile PC, both less and more powerful than a traditional laptop," she said. "The whole ultralight movement has pushed the size of the notebooks to ever slimmer and more streamlined units. When you consider the work being done on flexible screens, wireless charging and multipurpose ports, the notebook 10 years out could fit in your pocket or purse, and be able to expand to a variety of configurations at the touch of a button or the flick of a wrist."

The wait for change may not even be as long as that. Prof Subramanian hopes haptic feedback will be available on laptops within the next five years, Intel promised devices running RealSense this year, and Microsoft says its HoloLens will be with us soon too.

This changes everything

Whatever the time frame, it's looking pretty certain that a combination of the technologies discussed here will form the basis for the next step in computing. Smartphones took computers off our desks and put them in our pockets, to an extent unimaginable 10 years ago. In the next 10 years, then, it's not

improbable that we could achieve something similar to the computing experience seen in science fiction such as *Star Trek*.

It's hard to talk about specifics, as our acceptance of these technologies is far more key than the technologies themselves – look at Google Glass as an example of a socially spurned idea. The only certainty is that the next step will look – and feel – different from computing today. The standard model of inputting your ideas via a keyboard, touchscreen or 2D camera and manipulating them on a flat display will be over, meaning the physical design will be different, too. Our desktops may look more like the HP Sprout, with more cameras and smart desktops built in, and our laptops might be reduced to a smartphone-powered hologram viewed through AR glasses.

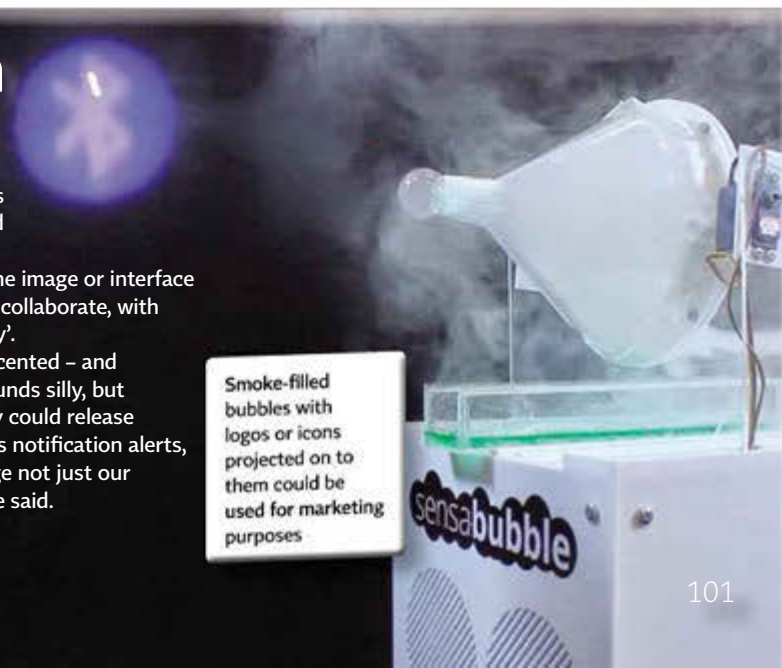
Whichever way these technologies eventually manifest themselves, the impact will be huge. The internet now contains immense amounts of data, but it's all locked away behind a screen. The ability to map all that data directly on to our physical surroundings, and to interact with it in a natural way, would make the impact of the smartphone seem almost insignificant. ☐

Misting up your screen

Forget monitors or even augmented reality headsets: the University of Bristol's Professor Sriram Subramanian has developed ways to display digital content in mist and on bubbles. "What we're looking at in our lab is dynamically creating a display for you at the moment that you need it and then it's gone," he said. "It's just a puff of air that goes away."

First, there's the Mistable. Fog or mist is projected into a space, with the image or interface projected into it. That allows users to interact with 3D images and also to collaborate, with everyone able to see it and reach into it, even if they're behind the 'display'.

Then there's SensaBubble. Bubbles are filled with fog – which can be scented – and tracked by a Kinect-style camera, with images projected on to them. It sounds silly, but Subramanian has suggested using them to promote businesses – a bakery could release bubbles with its logo, filled with the smell of fresh baked bread, say – or as notification alerts, with certain smells associated with the time, for example. "Then we engage not just our visual senses but also our sense of taste, our sense of smell and so on," he said.





OS EXPLAINED

What does your operating system really do? **Mike Bedford** explains all in this in-depth guide to the brains behind your PC

The launch of a new version of Windows is always a major event in the world of PCs. The introduction of Windows 10 this year means the operating system is, once again, vying for our attention. Although it's the most visible element of a computer, in some ways the operating system is the least well understood. It's easy to view it simply as the means through which we interact with a PC – mainly to start and stop applications – but it's actually much more than that. To give this unsung hero the respect it deserves, therefore, we're going to consider what an operating system really is and what it does, much of it behind the scenes.

We'll then delve into some real-world operating systems and see that Windows, in its various guises, is just the tip of the iceberg.

This exploration will show something of the differences between operating systems, and we'll also attempt to shed some light on that vexed question of whether some really are better than others. Understanding what makes things tick is always interesting but this exposé of operating systems isn't just to provide information – it could change your way of working. Windows isn't the only option for PCs so, if you come to the conclusion that a different operating system would serve you better, there's nothing to stop you either making the switch or installing an alternative alongside Microsoft's own effort.

A FUNDAMENTAL REQUIREMENT

To see the fundamental role played by the operating system, and the huge benefit it bestows, we have to go back to the operation

of the very first computers in the late 1940s. In particular, we need to look at some vital system software which performed a job that's now the most important task of any operating system, even though the term operating system wouldn't be coined for some time.

The primary job of a computer is to execute a program that comprises a series of instructions which are stored in memory. In the earliest computers, loading the program into memory in the first place was a laborious job that had to be done by entering each instruction as a binary number using switches on the computer's front panel. This could only be done at a rate of once every 15 seconds, so entering even a short program would take several minutes, while a longer one could take hours. In addition, it's all too easy to make a mistake when entering a program manually.



This was especially true since the instructions were just binary numbers so errors wouldn't be nearly as obvious as they would be in entering something more meaningful such as text. Today, we're used to being able to load a program with virtually no possibility of errors with just a click on an icon, even though many of those programs contain millions of instructions so entering them manually would quite literally take months.

The first step in being able to load programs more quickly involved reading them from punch cards but, without some sort of software, the computer wouldn't know how to read those punch cards – so the software to load applications from punch cards had to be entered manually. This may not sound like a huge advantage until we realise that those loader programs were designed to be very short. So entering a short load program – and using that to load larger application software from punch cards – did provide a major advantage. (To learn more about the use of system software to load applications, take a look at 'The Strange Tale of Booting' on page 107.) Suffice to say that being able to load application software from disk is integral to all modern operating systems.

MULTITASKING

While at the most basic level the operating system allows a program to be loaded from disk and executed, virtually all modern operating systems go far beyond this by implementing multitasking. This means several programs can run at the same time, or so it appears. What's more, multitasking predates processors with multiple cores.

Multitasking first came to the fore with large mainframes and mini-computers where users, on perhaps dozens of terminals, would each be able to run their programs and get timely responses. In computers with just one

single-cored processor, this was achieved by time-slicing, a technique that involved running each program for a fraction of a second before moving on to the next and eventually cycling back to the first. This scheduling was a key task for the operating system, and it sometimes involved maintaining several programs in memory simultaneously. Multitasking was also required when the memory was full, something the operating system achieved by writing the state of some programs to disk and loading them back to memory when their time slot was available.

Windows brought multitasking to the PC, but not to support lots of users. Instead, it allowed multiple applications to be open onscreen so that it was no longer necessary, for example, to close the word processor to read an email. Users could also leave power-hungry tasks such as media creation to work in the background while they carried out regular office-type tasks.

With the common availability of multicore processors, operating systems are now able to distribute tasks between cores. However, time-slicing is still an important technique as it means the number of simultaneous tasks isn't limited by the number of cores.

FILE HANDLING

Another of the most fundamental facilities provided by the operating system is some means of file handling, something that's essential to any PC user; even if you don't drag and drop files much any more, you'll need a file handler to download a photo or PDF to your PC. Here we're thinking primarily of a means of seeing what files are present in the various drives and folders, moving them from one drive or folder to another, and copying, renaming and deleting them.

While these types of file-handling tasks are familiar to most computer users, none

MICROSOFT'S A-VERSION TO CHANGE

You might be surprised to learn that the number on the Windows box no longer matches up to the version number of the operating system itself. It all started well enough with Windows 1.0 back in 1985, and Windows 2.0 and 3.0 followed the logical pattern.

Windows 95 changed tack from a marketing point of view, but under the hood the name Windows 4.0 made perfect sense. Windows 98 was 4.1, while Windows XP was called 5.1 (as technically speaking it followed on from Windows 2000 NT 5.0).

Things started to go wrong with the introduction of Windows Vista in 2007, which was named version 6.0. The problem was that many of the mass of applications written during the lengthy XP years simply couldn't cope with an operating system that wasn't 5.x. It was this change that largely led to Vista's now notorious compatibility problems with older software.

Microsoft decided not to make a bad situation worse, so with the launch of Windows 7, despite its official moniker, the version number was simply bumped to 6.1. This meant that any quick fixes that software developers had made should have continued to work. The thinking even continued with Windows 8, which goes under 6.2, and Windows 8.1, which is 6.3.

Thankfully it looks like Windows 10 is wiping away all that confusion, sort of, with a little misdirection. The new operating system will be called version 10.0 by all accounts when it's released. However, any old software that hasn't been written specifically to work with the new operating system will be tricked into seeing the version number as 6.2 (Windows 8). Newer software will have the correct code to see the real version number and therefore be able to make full use of the new features. So Microsoft has finally fixed the problem, with a little smoke and mirrors.

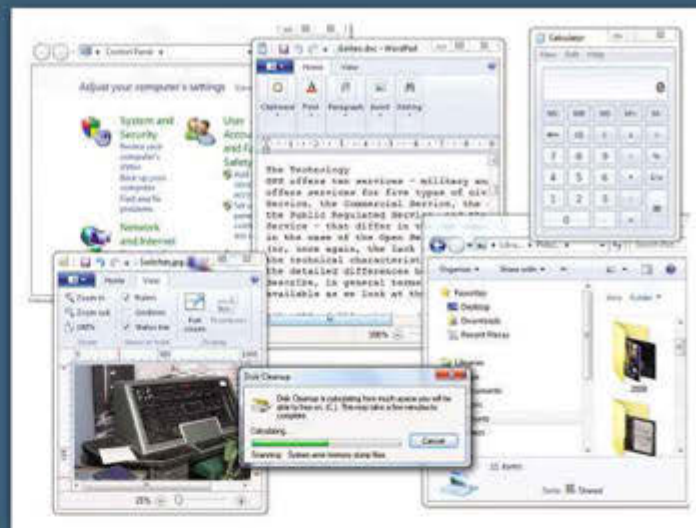


↑ You can see what version number of Windows you have by simply hitting Start, typing 'winver' and pressing Enter

BUNDLED UTILITIES

Most operating systems come bundled with a whole load of utilities that, strictly speaking, are separate applications rather than features of the OS. However, it would be splitting hairs to ignore them; indeed, they've been present since the very early days. Some of the MS-DOS commands, for example, actually caused separate programs to run, and bundled utilities have been a part of the Windows experience since the introduction of a clock and a calculator in Windows 1.0.

Operating systems increasingly include lots of separate programs, and much of what we consider to be core functionality is really provided by a separate application that runs under the host OS. Here we could include some of the most fundamental facilities such as the File Manager and Windows Explorer, plus a whole raft of peripheral applications such as Paint and WordPad. But the question of what is and what isn't part of the operating system goes deeper than this. No longer is the operating system a single huge program, even if we strip away these bundled utilities. Because operating systems allow multiple programs to run concurrently, it makes sense for the operating system itself to be split into several smaller, more manageable programs.

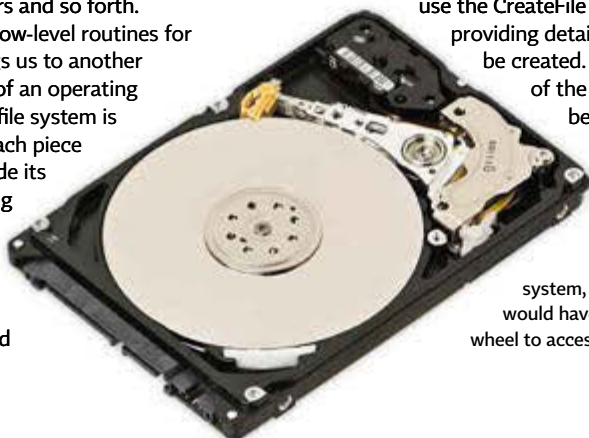


Operating systems now include dozens of programs and bundled utilities

of it would be possible without a more basic yet essential element of any operating system, namely the file system. Without a file system, a program could write to a disk, but those bytes of information recorded in the media wouldn't be recognisable as a file to application software. Instead, so that all programs can share files, and the operating system can provide users with file-handling tools, it's necessary to have a definition of the way files are stored and a set of low-level routines for accessing those files.

Computer files and file systems are so called because of their similarity to paper files and the systems used for storing them. Paper documents are put into labelled hanging files, these are put in the labelled drawers of a filing cabinet, and the filing cabinets themselves are labelled. This hierarchical structure makes it far easier to find particular documents. A computer file system works in much the same way. First it defines how a single file is separated from all the other data on a disk, usually by way of a header and a footer which define where the file starts and ends. This way, the file can be viewed as a separate entity, just as a sheet of paper would be in a manual filing system. Next, it defines a structure in which files can be placed together with similar files in a folder or directory (the terminology differs between operating systems), and these can be bundled together in higher-level folders and so forth.

Our mention of low-level routines for accessing files brings us to another important element of an operating system. Even if the file system is defined, requiring each piece of software to include its own code for reading and writing data from files and carrying out other common file-handling tasks would



Operating systems with a command-line interface provided a very different user interface

involve a huge duplication of effort. For this reason, the operating system provides something called an Application Programming Interface (API), which allows a programmer to create or access a file using code that's built into the OS. So, for example, to create a new file, instead of having to write dozens of lines of code, a Windows programmer can simply

use the **CreateFile** function, providing details of the file to be created. The concept of the API goes far beyond the file system, providing

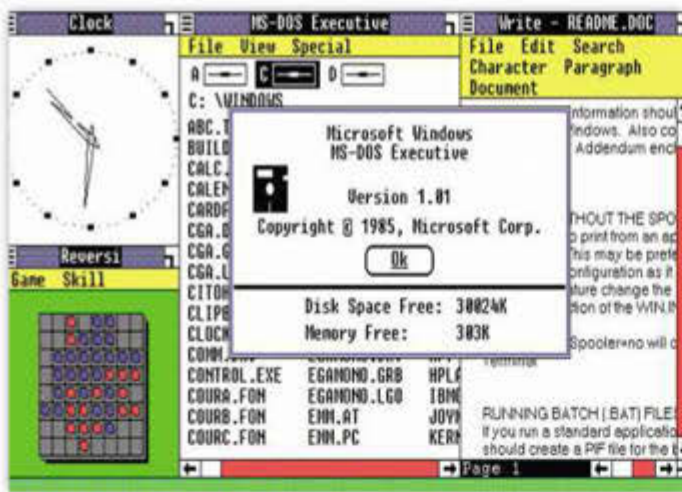
Without a file system, each application would have to reinvent the wheel to access data from disk

programmers with easy access to all the major elements of the operating system.

LOOK AND FEEL

For some users, a new user interface might be the most significant benefit offered by one operating system compared to its rivals. More technically minded users, on the other hand, might be inclined to dismiss the way in which we interact with the operating system as largely irrelevant. We'd like to suggest that neither view is correct and, while the look and feel isn't always the most important aspect of an operating system, developments here can bring about huge productivity benefits. A classic example was the introduction of the graphical user interface (GUI) to the world of PCs with the first version of Windows in 1985.

Before the days of Windows, PCs were shipped with the MS-DOS operating system, which provided a command-line user interface.



↑ It may have given us a graphical user interface for the first time, but Windows 1.0 wasn't an operating system in its own right

When you switched on your machine, you'd be presented with an introductory message such as 'Starting MS-DOS...' at the top of the screen and, below it, 'C:\>'. This was the so-called command-line prompt, and it indicated that the current directory (or folder in modern Windows terminology) was the root directory on the C: disk and that MS-DOS was awaiting your instruction. That instruction would be given as a textual command so, for example, if you wanted to run WordPerfect, a popular MS-DOS word processor, you'd type WP followed by the Enter key. However, WordPerfect wasn't usually installed in the root directory, so you'd first have to change the directory by typing 'cd\WP51' followed by Enter to change to the directory in which WordPerfect 5.1 was installed. Having to type these two commands may not have been a huge disadvantage compared to clicking on an icon, but other commands were a lot trickier.

For a start, you had to remember the names of all the commands and know how to use them. Some would become second nature, but for the less commonly used ones you'd probably end up typing Help so that MS-DOS would list the format for each of its dozens of commands. Even if you knew the syntax of the command, though, many instructions would be much longer than the example we've given, with the ever-present possibility of making an error. So to copy a file from a directory called Documents on floppy disk drive A: to a similarly named directory on the C: hard drive, for example, you needed to type something like: 'copy a:\documents\letter1.wp c:\documents'. Needless to say, error messages such as 'Could not find C:\documents\letter1.wp', resulting from a misspelled filename, were commonplace.

The advantages provided by a graphical user interface aren't hard to appreciate, but that first version of Windows wasn't actually an operating system in its own right. Instead, it was a graphical front end that ran within MS-DOS. So MS-DOS started up normally, even if Windows 1.0 was installed, and if you wanted to use Windows you'd first have to type 'Win' at the command prompt. In fact, Windows 2.0, 3.0, 3.1, 95, 98 and Me would all come and go before Windows became a fully

fledged operating system with Windows XP in 2001 (although, for servers, Windows NT had made this breakthrough several years earlier).

COMPARING OPERATING SYSTEMS

Sometimes a new operating system is clearly a departure from its predecessor in having a different user interface. Windows 8 was a classic example in providing a markedly different look and feel to Windows 7 and, for that matter, to most versions of Windows that went before it. Other Windows upgrades provided a user interface that was little changed but offered some major new functionality. While the aesthetic differences that Windows XP brought were only skin deep, for example, this was the first mainstream version of Windows for which a 64-bit edition was available.



↑ Each version of Windows has brought a new look and feel, although the behind-the-scenes differences were often more significant

With most operating systems, Windows or otherwise, now providing support for 64-bit processors and – except for Windows 8 and 10 and Android, with their tile-based user interfaces – most having a very similar look and feel, what does differentiate operating systems? Do Linux, BSD or OS X (formerly Mac OS X), for example, really provide any benefits over their Windows counterparts, as supporters of these alternatives might claim?

To get some thoughts on this question, we spoke to Professor Timothy Roscoe, an expert in operating systems in the department of computer science at ETH Zürich. Roscoe explained that most of today's mainstream operating systems are related to Unix in one way or another, suggesting that the difference might not be as fundamental as we might have thought.

HOW 'QUICK AND DIRTY' WON MICROSOFT THE CLONE WARS

A long time ago, back in 1980, IBM was the top dog in computing. However, other companies' personal computers (as opposed to the big business mainframes) were starting to appear and were undercutting IBM's product. In response the company came up with its platform-defining IBM Personal Computer, but time was tight and so it turned to a variety of external companies for the various elements.

While the processor came from Intel, the operating system was sourced from Microsoft. However, the company didn't have the necessary code and so it looked around for someone who did. Its first efforts were to broker a deal between IBM and a company called Digital Research, but when this fell through Microsoft quickly purchased the rights to Seattle Computer Products' Quick and Dirty Operating System (QDOS). Microsoft tidied up the code, and it launched with the IBM Personal Computer as PC DOS.

However, Bill Gates had cleverly bartered away the rights to perpetual royalty payments from IBM in return for the rights to sell PC DOS, later renamed MS-DOS, to any computer manufacturer it wanted. Gates looked to have foreseen the huge rise in clone PC makers the IBM PC would create – largely because it was built from off-the-shelf parts, but also because of the high prices IBM was charging. Microsoft boomed off the back of licensing MS-DOS to these PC clone makers, it went on to create Windows in 1985 and the rest is history. Which is why Microsoft and Windows are synonymous with the PC, while IBM has become something of a footnote.



↑ The young Bill Gates struck a deal with IBM that set Microsoft on the path to global PC domination



"Linux, BSD, OS X, iOS, Android, Windows, and Solaris are really quite similar," he said. "Linux, Solaris, and BSD obviously trace their lineage directly back to Unix; Android is Linux, OS X and iOS are the Mach microkernel with the BSD emulation subsystem moved into the kernel, and Windows is a descendent of VMS, which was DEC's proprietary alternative to Unix back in their day," he went on to explain.

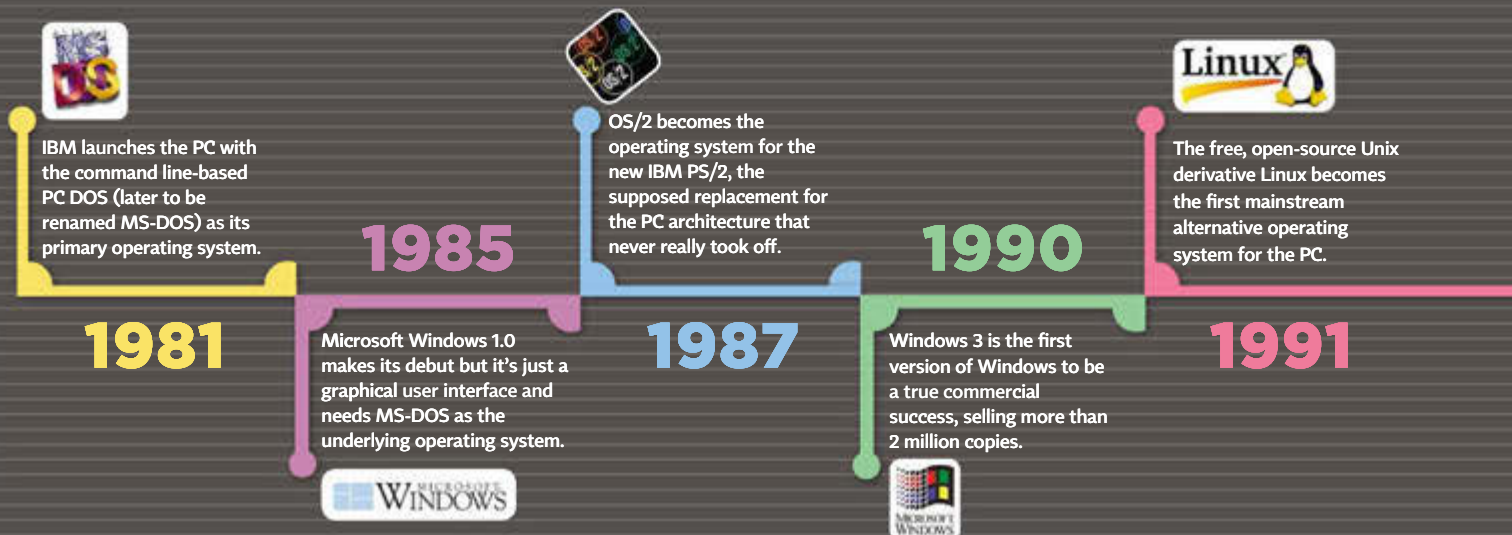
Despite their common roots, since Linux split from Unix almost a quarter of a century ago, and even OS X made the break in 2001, there's been quite some potential for divergence. We asked Roscoe if any significant differences have emerged that would affect the user experience. In particular, we wanted to know whether there were any major performance differences between mainstream operating systems.

"It's really impossible to say for a bunch of reasons", he told us, explaining that it all depended on issues such as how performance is measured, the type of application, exact details of the hardware configuration, and whether we assume that users have the skills necessary for specialist tuning or tweaking of the operating system. He summarised by claiming that, "for any mainstream operating system, I suspect someone could come up with a plausible benchmark and hardware platform that demonstrates clear superiority over all others".

Despite all this, for many people the choice of operating system will come down to something much more mundane, namely the availability of software. While exact figures are hard to come by, the differences certainly appear to be dramatic, with Microsoft recently claiming over 4 million available applications for Windows. Indications are that the corresponding figures for OS X and Linux are 650,000 and a few tens of thousands respectively. This wouldn't be a major issue if most of those millions of Windows applications were obscure, specialist or rarely used, but some of the major productivity packages aren't available if you abandon Windows. Even Microsoft Office, for example,



PC operating system timeline



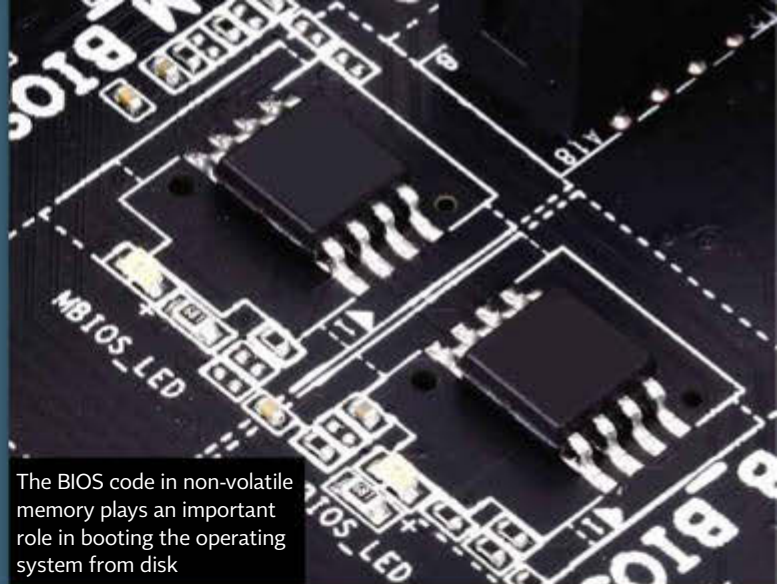
THE STRANGE TALE OF BOOTING

Ever wondered why starting a PC is often referred to as booting? Perhaps you thought it's some sort of reference to kicking it into action, but the truth is stranger than that. It's actually short for bootstrapping and is a reference to the concept of picking yourself up by your own bootstraps, or shoelaces if you prefer a somewhat less American turn of phrase, and was considered to be an analogy to the difficulty of loading software into a computer.

As we saw in the main part of this article, unless you do it manually, loading application software requires some sort of software which itself needs to be loaded into memory. Elsewhere we describe how the load program had to be loaded manually in the first computers, but this was something of an oversimplification, and bootstrapping sometimes described a more complicated multi-stage process.

If software had to be loaded manually, there was a clear benefit in making that software as short as possible. Unfortunately, short programs tend not to be too clever and might only be able to read the contents of a single punch card into memory, not the whole deck on which application programs were stored. However, that single punch card could hold a longer program than you'd want to enter manually each time the computer was switched on and might hold a more sophisticated load program that could handle a deck of cards.

Eventually, means were found of hard-wiring the initial load program so it didn't have to be entered manually. However, because hard-wired software was expensive, multi-stage bootstrapping continued.



The BIOS code in non-volatile memory plays an important role in booting the operating system from disk

This isn't just a history lesson, though, as much the same happens in modern PCs. When you first switch on your PC it executes software called the BIOS (Basic Input/Output System), which is stored in non-volatile flash memory on the motherboard. Because flash memory is now comparatively cheap, the BIOS is a lot more sophisticated than the hard-wired load programs of old. First it tests the hardware to ensure it's working correctly, and only if the PC passes this so-called POST (Power On Self Test) does the BIOS go on to load the operating system from the hard disk. From now on, the operating system will be responsible for loading applications from disk, but the parallels with bootstrapping those early computers are clear to see.

hasn't yet bridged the gap between Windows and Linux. Perhaps the surprise figure, though, is the 1.3 million apps that are available for Android. It may pale into insignificance next to Windows' 4 million, but we shouldn't lose sight of the fact that Windows has 28 years under its belt while Android is most definitely the new kid on the block, having been released less than seven years ago.

THE ROAD AHEAD

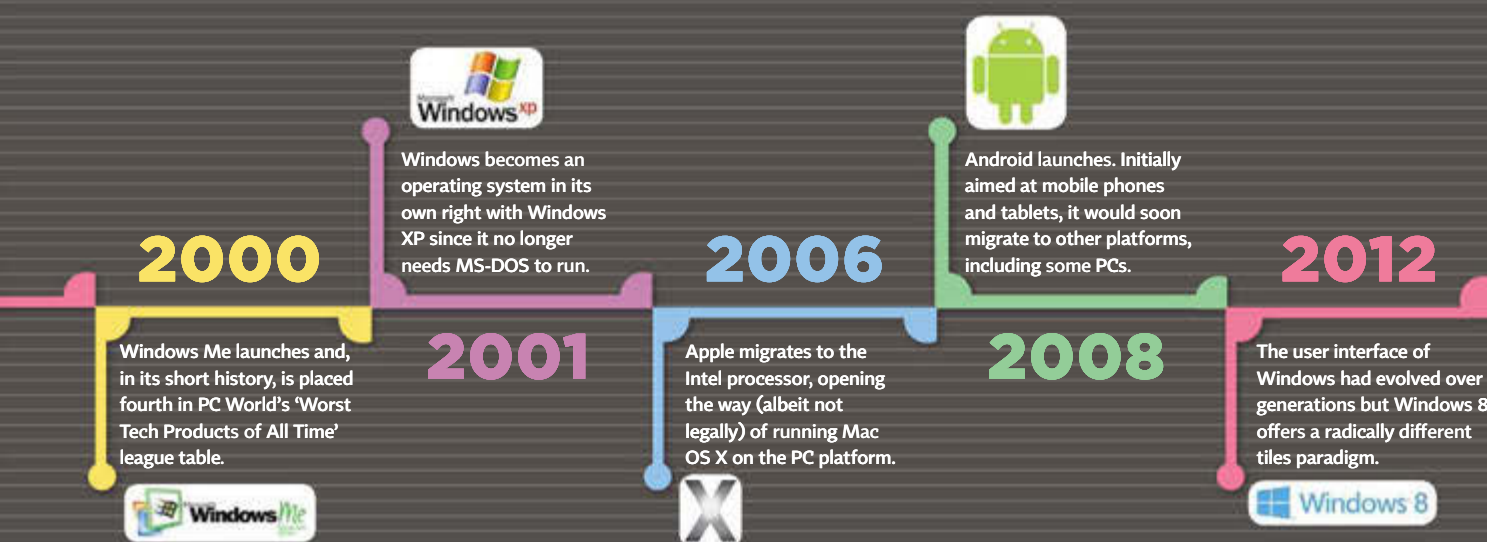
With the exception of the ever-changing user interface, and support for new hardware such as 64-bit processors a few years ago, it's been suggested that the development of mainstream operating systems stalled many years ago. We asked Professor Roscoe if he

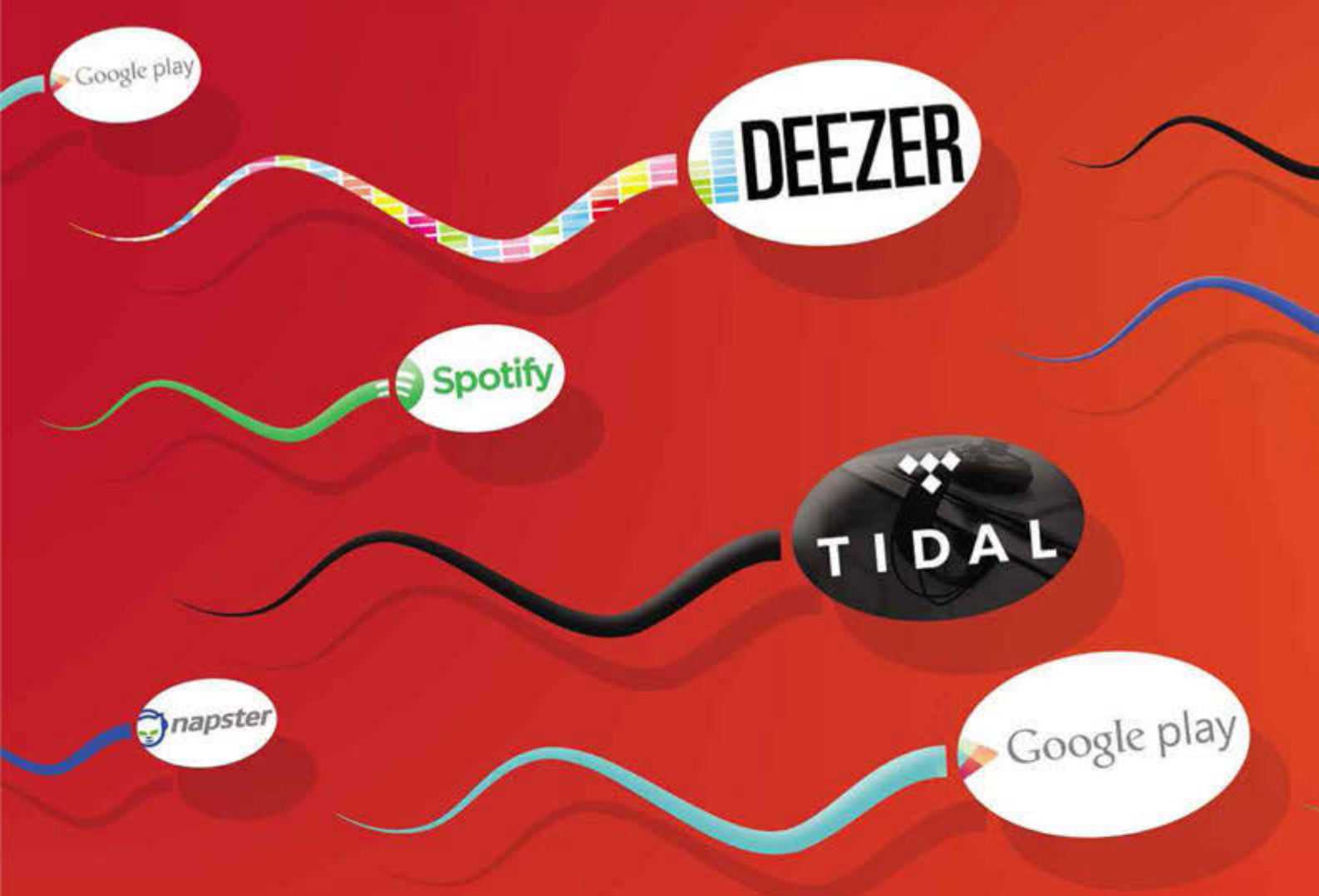
agreed with that view and, in the main, he did. While recognising that support had been provided for new types of hardware such as networking, graphics, power and energy management and multicore processors, he said that the basic structure of Unix remains the same as it was in 1974. Given that most PC operating systems can trace their heritage back to Unix, that would seem to suggest that while hardware has changed out of all recognition over that time, our operating systems are still in the Dark Ages.

So are we destined to see further new operating systems that represent evolutionary rather than revolutionary changes, or are there moves afoot in the realm of operating system research that will genuinely bring us

huge gains in the future? Again we asked Roscoe for his views. "It will happen in the server space first," he said, before listing some of the basic trends he envisaged. In the main, these are support for a lot more cores, not all of which will be powered on at once, highly heterogeneous and specialised cores, and very large memories.

"Current designs for operating systems are probably OK on small devices like phones and PCs for the next few years", Roscoe suggested, "but eventually the changes will percolate down from the larger systems, just as Unix and Windows did into Android, iOS, and the Windows Phone." It looks like your Windows skills will stand you in good stead for some time to come, then. ☑





MUSIC TO

Spotify, Google, Tidal, Deezer and Napster are all fighting for music-lovers' attention. We find out which streaming service is best for you

Music-streaming services are revolutionising how we listen to music. Fewer of us now store our music locally on our devices and even fewer are buying physical copies, regardless of vinyl's well-documented resurgence. In 2014 alone, music streaming in the UK doubled in size, with over 14.8 billion audio streams listened to in the UK.

Not only do streaming services provide a huge catalogue of artists and albums, it means music is available on all your devices, whether you want to listen on your PC, smartphone, tablet or through multiroom speakers. If you pay a monthly fee you can usually take your music with you on the move without any data costs.

The wide range of streaming options can make it difficult to decide which service is right for you. We've looked at five of the most popular services, comparing prices,

bit rates and app support to help you decide which music-streaming service is best for you. We'll also give you an idea of what music is available on each service.

MUSICAL CHOICE

Music licensing can be a minefield when it comes to royalty agreements between the service, publishers and artists, which means that not all your favourite musicians might be available to stream on all of the services – or, in some cases, any at all. This is the one Achilles heel in music streaming, but for the most part the convenience and ubiquity outweighs the shortcomings.

Some streaming services allow you to upload your own music to their servers, so you can access your own tracks in the same way as tracks in their catalogues. This means that music you've bought and digitally downloaded or even ripped from



YOUR EARS

your own physical music, such as CDs or vinyl, can be made available on all of your devices, no matter where you are.

We can't account for everyone's musical tastes but we've tried to use a good mix of music, both in terms of genres as well as eras, to give an impression of the diversity of a service's catalogue. You can find out what is and isn't available on each service on page 112.

APPS AND MULTIROOM

Most music-streaming services lets you play music from different devices, such as your PC, tablet or smartphone. You can normally access the music in different ways as well. On a desktop or laptop PC you tend to have the option of using a browser or dedicated piece of software.

As a lot of us tend to listen to music while on the move, most services also

provide mobile apps. These tend to be available on iOS and Android. Windows Phone unfortunately isn't quite so well supported, but we've mentioned what apps are available in our individual streaming service breakdowns.

Multiroom speakers (see Group Test, *Shopper* 325) are another great way to experience music streaming around the home. With speakers located in different rooms you can listen to music in one room and then pick up where you left off in another, pipe the same music around your entire home or have different songs playing in different rooms. However, support for streaming services is at the mercy of the multiroom speaker manufacturer, so you'll need to make sure your chosen service is supported by your speakers. Thankfully, a lot of multiroom speakers get updated with new services over time.

SOUND QUALITY

Audio quality will ultimately be decided by what equipment you use to listen to your music, whether that be headphones or speakers, but you can also ensure that the source is of high quality. Most streaming services will give you a range of quality options, which will be useful if you're on a limited data contract and plan on streaming from your smartphone. At the top end of the quality spectrum, you'll usually find bit rates of 320Kbit/s.

However, many services are increasingly beginning to offer even higher bit rates all the way up to 1,411Kbit/s, which is lossless CD quality. This requires a lot more bandwidth as the files themselves are much larger, carrying far more data per second. Whether or not you can hear the difference will depend on the quality of your equipment, however.



Price Free/£9.99 per month (Spotify Premium)
Bit rate 320Kbit/s (Spotify Premium); 160Kbit/s; 96Kbit/s
Apps Web player, Windows, Mac, iOS, Android, Windows Phone

SPOTIFY HAS BECOME synonymous with music streaming since its launch in 2008. It has grown to over 10 million users, 2.5 million of which are paid subscribers. It's also the most supported music-streaming service when it comes to multiroom audio and media streamers. Spotify does lots exclusive work with performers, so is a potential goldmine for those looking for live performances as part of its 'Spotify Sessions' series.

Spotify Free, as the name implies, costs nothing and is instead ad-supported on PCs. You're able to create and listen to playlists and albums, but you'll intermittently hear adverts between tracks, which can rather kill the party, or your romantic dinner for two. Even if you're a Free user, you get access to Spotify's curated playlists and music recommendations.

The Spotify experience gets a bit more convoluted when using the Spotify app on smartphones and tablets, however. Using a Spotify Free account on a smartphone you're able to listen to playlists or use Spotify's Radio service, which chooses tracks for you in shuffle mode. You're not able to play specific tracks, though. Pressing 'Play' will start a mix of an album or artist with similar or suggested tracks thrown in. You can also only skip up to six songs per hour.

On tablets, you're able to choose specific tracks to play without restriction, much like on PCs. Spotify considers the tablet



↑ Spotify is available across a multitude of platforms and devices, including PCs, phones and tablets

experience to be more like using a PC, so you're still also able to create playlists.

SPOTIFY PREMIUM

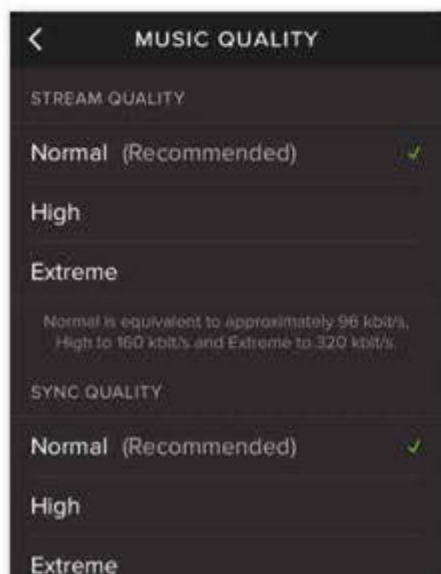
Spotify's paid offering is Spotify Premium, which is available for £9.99 a month. This gives you access to offline mode for your mobile devices, allowing you to download and save albums and playlists so you don't need a data or internet connection to listen to music. This also gives you access to high-quality streaming (320Kbit/s), whereas you're limited to 160Kbit/s on a Free account.

you're outside, provided you have an internet connection. Each Spotify Connect-compatible device connects directly to Spotify to stream music from the service rather than using the controlling device.

APPS AND MULTIROOM

Spotify is well supported across multiple platforms, including Windows, Mac OS X and mobile apps. There's still a lack of parity between different versions, however; lyric support is currently only available on PCs, for example.

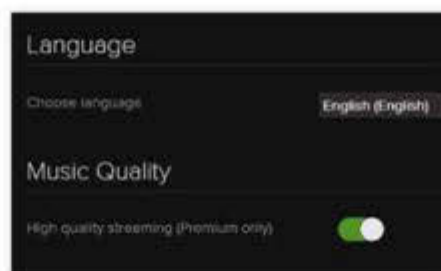
You can use the app or desktop software to control the music from any Spotify Connect-compatible speaker



↑ You can change the streaming quality in the mobile apps, useful if you need to conserve data

Premium also gives you access to Spotify Connect, which is integrated into many multiroom audio speakers and televisions. This lets you use the Spotify app or Windows/Mac OS software to control the music from any Spotify Connect-compatible speaker associated with your Premium account. This means you can start playing music from your home speakers even when

The PC application can also be used to synchronise your own locally stored music tracks to your mobile device, so you don't have to manage two apps and two libraries if you have tracks that are unavailable to stream from Spotify. The synced music has to be in MP3, MP4 or M4P formats, though, and there are no options to upload your own tracks to the cloud.



↑ Be sure to turn on high-quality streaming in the PC application for the best sound quality

Spotify is supported by almost all of the multiroom speaker systems from the big names, including Sonos, LG and Samsung, either through Spotify Connect or via native integration with their controller apps. Spotify also recently announced a partnership with Sony that sees the service brought to the PlayStation 3 and PlayStation 4 consoles. We're big fans of the Sonos implementation, which lets you stream different tracks to different rooms at the same time; with every other service, you can only stream a single song through Spotify Connect.



DEEZER

Price Free/£9.99 per month (Premium+)
Bit rate 1,411Kbit/s FLAC (Sonos only);
 320Kbit/s; 128Kbit/s
Apps Web player, Windows, Mac, Android,
 iOS, Windows Phone

DEEZER LAUNCHED IN 2007, and with six million paying subscribers and more than 35 million tracks it's one of the biggest services around. It's available in more countries than Spotify, both as a restricted Free account and Premium+ for £9.99 a month.

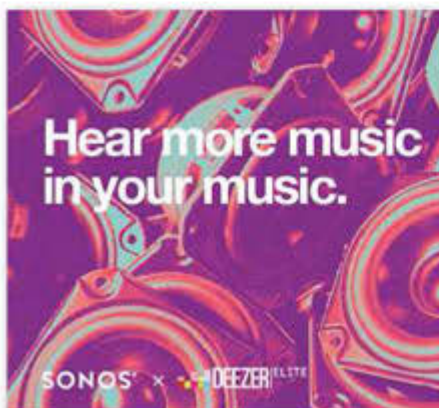
A Free account lets you play unlimited music on computers and tablets, while you're restricted to radio channels and Deezer's tailored recommendation service Flow on smartphones. The Free service is supported by ads, and you're limited to skipping up to six tracks per hour. You'll also get the occasional video advert overlay that takes over the site. It's intrusive and means you can't navigate the page until the advert is finished, which is annoying. Deezer has integrated lyrics for certain songs on the PC interface.

Like Spotify, a number of 'apps' are built into the Deezer service itself that you can install. These are like browser extensions and offer different ways to enjoy the experience, such as quizzes. There's also an app that lets you import playlists from Spotify to Deezer, useful for anyone moving between services.

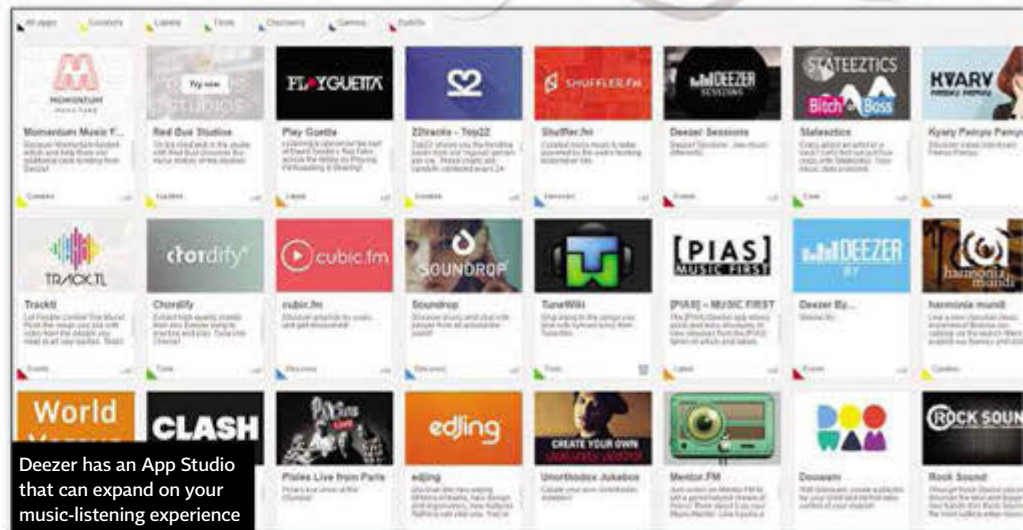
'Deezer Sessions' are videos of exclusive live performances, again similar to Spotify's works with performers and are a source of performances you won't find elsewhere if you don't just want to listen to studio recordings.

PREMIUM+ AND DEEZER ELITE

If you're using a Free account you're limited to lower-quality streams at 128Kbit/s, whereas with Premium+ you have access to 320Kbit/s. You also get access to offline music by subscribing, letting you listen to tracks on the



↑ Deezer Elite is only available on Sonos, but provides high-quality FLAC streaming



go without worrying about data costs, and of course you get unlimited skipping of tracks if you're listening to a curated playlist through Flow. Your music listening also won't be interrupted by ads and you can import your own MP3s to use alongside Deezer's library.

Deezer recently announced that its 'Deezer Elite' service is soon to launch outside of the US. This provides access to 1,411Kbit/s streams in FLAC format. Sadly, Deezer Elite is available only on Sonos speakers, although at least there won't be any additional charge for the improved quality if you're an existing Deezer Premium+ subscriber with a Sonos speaker. Pricing for new subscribers is slightly more expensive at £14.99 if you opt for the

rolling monthly option, or £120 for a year. This makes Deezer Elite half the price of a Tidal subscription if you happen to have Sonos speakers.

APPS AND MULTIROOM

Deezer is well supported when it comes to apps. There are desktop applications for both Windows and Mac, as well as a fully featured web based player. On mobile there are iOS, Android and Windows Phone apps. Deezer also does well when it comes to multiroom audio, with support from most of the big players, including Sonos (bolstered by the aforementioned Deezer Elite partnership), Samsung, Denon, LG and Bluesound.

AMAZON MUSIC

Amazon also offers a cloud-based music-streaming service. With a free account you can upload 250 of your own tracks, which are then available to stream via Windows or Mac browsers as well as iOS, Android and Kindle Fire apps. The Sonos Connect multiroom app also supports the service. You can install software for Windows or Mac OS that monitors your music library and automatically uploads tracks to the cloud. There's also the option of a yearly subscription that costs £22 a year and allows you to upload up to 250,000 tracks.

The other useful feature of Amazon Music is AutoRip. If you buy a physical copy of eligible music from Amazon, whether it's a single or album on CD or vinyl, Amazon will automatically provide a free MP3 version that's available from your Amazon Music library. This doesn't count towards the upload limit, even if you're on the free subscription. This is ideal if you still like to own physical copies of your music but also want the convenience of having a digital version. The digital version is normally provided instantly, which is great if you want to get listening before you receive your music in the post.

➔ Amazon Music's AutoRip gives you a digital version of CDs or vinyl you've bought



TIDAL

Price £9.99/£19.99 per month

Bit rate 96Kbit/s (AAC); 320Kbit/s (AAC); 1,411Kbit/s (FLAC)

Apps Web player, Android, iOS

It's a bit annoying to fail to find a track on Tidal when you're paying twice as much for the service

WHEN TIDAL LAUNCHED it was advertised as the audiophile's streaming service. It's now owned by the musician Jay Z, who bought its parent company Aspiro, and who operates the service along with other well-established artists. This cabal of music behemoths were ridiculed for saying they thought music royalties should be bigger, one of the reasons that Tidal is more expensive than most, but then we're sure a lot of struggling smaller acts are probably in strong agreement with them.

Tidal's strength is in what it describes as 'lossless streaming'. While rival services such as Spotify and Google Play Music All Access top out at 320Kbit/s, Tidal streams its music

at up to 1,411Kbit/s in FLAC (Free Lossless Audio Codec) format. This is equivalent to lossless CD quality, although this shouldn't be confused with high-resolution audio, which uses up to 24-bit/192kHz files that equate to 9,216Kbit/s and substantially larger file sizes.

Still, 1,411Kbit/s is considerably better quality than a 320Kbit/s file. Whether or not you can hear the difference is debatable, and will be dependent on your music playback equipment. Differences in quality will be more obvious with high-quality headphones or speakers than with a cheap pair of earbuds. Tidal actually has a lossless sound quality test to see if you're able to hear the difference,

which is worth trying to see if you'll actually benefit from the service (test.tidalhifi.com).

At £19.99 a month for lossless quality, Tidal is considerably more expensive than other streaming services and its music catalogue isn't quite as strong as its rivals. Tidal recently launched a £9.99/month subscription plan that is limited to 320Kbit/s streaming, which is competitive with Spotify. There isn't a free subscription plan of any sort.

There will be tracks you might find only on Tidal and not elsewhere, or vice versa. However, it's a bit annoying to fail to find a track on Tidal when you're paying twice as much for the service.

Like Spotify and Google Play Music All Access, Tidal curates and recommends music. Since its revamp it has launched a Tidal Rising section, which recommends music from up-and-coming artists that the service feels will benefit from the increased exposure. There are also exclusive music videos and performances as part of its Tidal X series.

APPS AND MULTIROOM

Tidal has apps available for iOS and Android, as well as desktop applications for Windows and Mac. There's also a web-based player, but the only way to play tracks in lossless FLAC is to use the Google Chrome browser. There's no support for Windows Phone at present.

Support for Tidal through multiroom speakers is increasing. Currently the most prominent supporters are Sonos, Bluesound, Astell & Kern, Polk and Raumfeld.

THE SHOPPER JUKEBOX

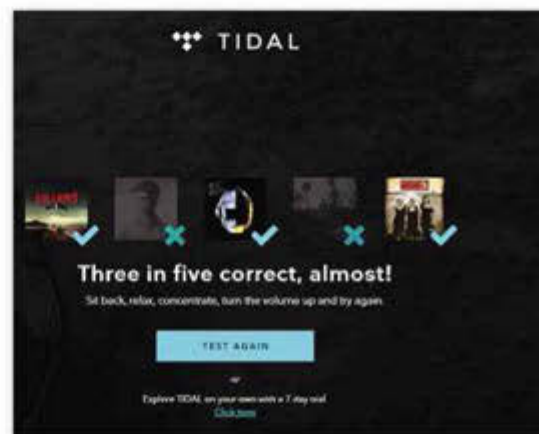
It's almost impossible to test which streaming service's music library best matches up to your tastes. Using recently released hit albums doesn't throw up many differences between the services, so instead we've gone for an eclectic selection from our team's own collections, along with hand-picked ones known for being hard to stream.

These include Menahan Street Band's funk and soul classic *Make the Road by Walking* and The Touré-Raichel Collective's *The Paris Session* for fans of world music. It's well known that Taylor Swift's latest album, *1989*, isn't available for streaming anywhere, so we've opted for one of her older albums, *Red*, to see what streaming availability is like across the services. AC/DC is another band that famously isn't widely available, so we've opted for their classic album *Back in Black*. We've also thrown in a number of soundtrack albums as well as niche genres such as the minimal techno album *Solid State* by Pluxus.

We've only marked a music service as having an album available if it has the entire album available to stream. On a number of occasions, such as the *Pulp Fiction* soundtrack that is a compilation album from various artists, only a handful of the tracks are available to stream. This can also occur with tracks from the same artist, such as Syntax's *Meccano Mind*, which only has one track available to stream from the album across all of the services we tested.

ARTIST	ALBUM	GENRE	SPOTIFY	GOOGLE PLAY	TIDAL	DEEZER	NAPSTER
AC/DC	Back in Black	Rock	×	×	×	×	×
Menahan Street Band	Make the Road by Walking	Soul	✓	×	✓	✓	✓
Touré-Raichel Collective	The Paris Session	World	✓	✓	✓	✓	✓
Taylor Swift	Red	Pop	×	✓	✓	×	✓
Kendrick Lamar	To Pimp a Butterfly	Hip hop	✓	✓	✓	✓	✓
Pendulum	Hold Your Colour	Drum & bass	✓	✓	×	✓	×
Burial	Untrue	Future garage	✓	✓	✓	✓	✓
Steely Dan	The Very Best of Steely Dan	Rock	✓	✓	✓	✓	✓
Syntax	Meccano Mind*	Synthpop	×	×	×	×	×
Pluxus	Solid State	Minimal techno	✓	×	✓	✓	✓
Joe Hisaishi	Spirited Away	Soundtrack	×	×	×	×	×
Ramin Djawadi	Game of Thrones	Soundtrack	✓	✓	✓	✓	✓
Book of Mormon Original Cast	Book of Mormon	Soundtrack	✓	✓	×	✓	✓
Nirvana	MTV Unplugged in New York	Rock	✓	✓	✓	✓	✓
Various Artists	Pulp Fiction*	Soundtrack	×	×	×	×	×

* Only some tracks



↑ The Tidal High Fidelity test can help you decide if your listening equipment can benefit from the upgrade to lossless sound



Price Free/£9.99 per month (Google Play Music All Access)

Bit rate 320Kbit/s; VBR

Apps Web player, Android, iOS

GOOGLE SELLS MUSIC via its Google Play Store but also offers a streaming service that combines cloud storage for your own music with access to Google's catalogue of tracks. Even with a free account, you're able to upload up to 50,000 of your own tracks to the cloud, which you can then access from any number of devices or locations. This was recently bumped up from an already generous 20,000-track storage capacity. This is a huge boon for those looking to fill gaps in Google's library by using their own music.

Google matches your uploaded music with its own catalogue, so if you upload an album it already has available, Google will provide access to its own version. This is even the case if you attempt to upload a lower bit-rate version, meaning you get access to Google's 320Kbit/s version instead, which is a nice upgrade. Google will only host music it doesn't have itself, saving on the company's own storage requirements.

With All Access you also get the option of saving offline albums and playlists, so you don't need a data connection to listen on your mobile devices, saving on data and roaming charges if you're abroad. An All Access subscription also provides access to Google's music discovery service, powered by its new acquisition, Songza. This recommends music and playlists based on different contexts.

In addition, Google recently rolled in access to its YouTube Music Key beta for subscribers to All Access. This lets you watch music videos on YouTube without the adverts, as well as background playback. This only applies to what YouTube has categorised as music, so those entertaining cat videos will still include adverts.

Normally when you exit the YouTube app on a mobile device, say to check your email or

upload new tracks automatically from your desktop when they're added to specific folders.

There are free apps available for Android, as you would expect, as well as iOS. If you're a Windows Phone user you're out of luck, though. Third-party apps are available for Windows Phone but many of these aren't free and don't quite provide the same experience.

Google Play Music All Access isn't very well supported when it comes to multiroom audio speakers at the moment. The biggest supporter is Sonos, which provides native integration with its Sonos Controller app.

However, to tackle this the company has launched Google Cast for Audio, which will handle multiroom audio much like the Chromecast stick handles video. You'll be able to stream music from Chrome or any Android or iOS app that supports it, to a Google Cast-enabled audio device (or a Chromecast, of course). At the moment the number of apps that support casting audio are limited, with Google Play Music and TuneIn Radio being two of the most well known. Hopefully this number will increase over time, as Google Cast hardware has only just been launched. A number of manufacturers, including Denon, Sony and LG, have already pledged support in releasing Google Cast-ready speakers.

Even with a free account, you're able to upload up to 50,000 of your own tracks to the cloud

If you're using a free account, you're only able to stream music that you've uploaded, but it's a great way to make your catalogue available across devices (up to 10 of them can be registered to your account). While hosting your music library, Google hopes you'll purchase tracks from its store.

GOOGLE PLAY MUSIC ALL ACCESS

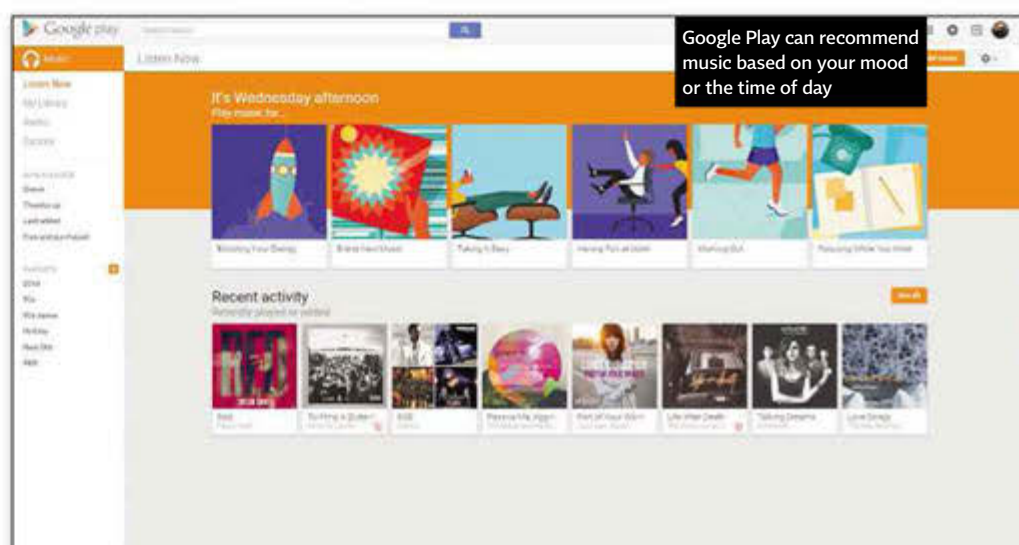
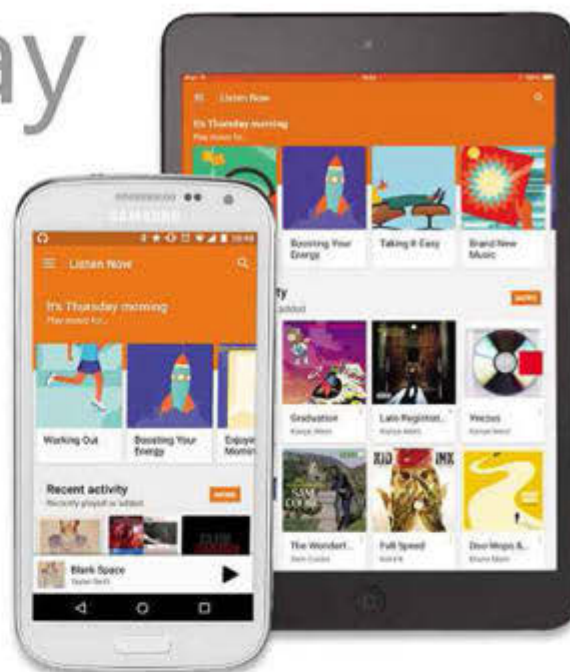
There have been a few hints that Google will adopt the less long-winded 'Google Play Unlimited' name in the near future, but for £9.99 a month you can subscribe to Google Play Music All Access, as it's currently known.

The service provides unlimited streaming of Google's music catalogue, as well as up to 50,000 tracks of your own music, as we mentioned above. It should be noted that not all tracks or albums that are sold by Google on its Google Play store are available to stream through All Access. As an example, the *Guardians of the Galaxy* soundtrack is available to purchase for £6.49 but is not available to stream even if you're a paid Google Play Music All Access subscriber. Any music you buy separately from the Play store doesn't count towards the 50,000-track limit.

texts, the music stops. With YouTube Music Key the audio will continue playing in the background, but again only for videos labelled as music. Similarly, you can also save music videos for offline playback and easy access.

APPS AND MULTIROOM

There's no dedicated PC software; instead you play your music through the web player. You can also use the web player to manage your uploaded music or download Google's software to monitor your music library to





Price £5 per month (Napster Unlimited);
£10 per month (Napster Unlimited Plus Mobile)
Bit rate 320Kbit/s; 192Kbit/s; 128Kbit/s; 64Kbit/s
Apps Web player, Windows, Mac, iOS,
Android, Windows Phone

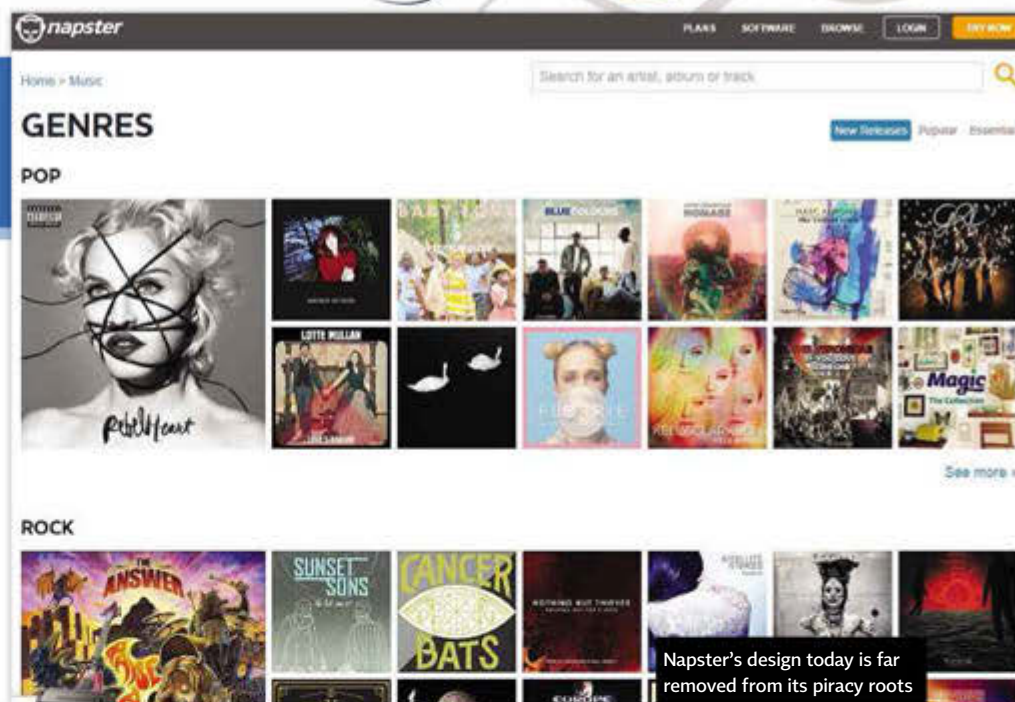
IF YOU REMEMBER the internet in the late 1990s, you might associate Napster with obtaining music through slightly unscrupulous means. Nowadays it's a legitimate music-streaming service with a catalogue of over 30 million tracks. Although arguably it's been around the longest, at least in name, it's not as well known or popular as some of its rivals.

NAPSTER UNLIMITED

Napster's subscription service is divided into Unlimited and Unlimited Plus Mobile. The latter is more expensive but provides access to mobile streaming from the Napster apps on mobile devices, whereas the cheaper plan only provides streaming from a PC.

Napster has improved its streaming quality over time. Previously the service was limited to 192Kbit/s, which was behind its rivals in terms of sound fidelity. Nowadays the quality you can stream at isn't so simple. If you're streaming from a PC you're limited to 128Kbit/s, though tracks downloaded using Napster's software are 192Kbit/s. Some tracks aren't available at the higher quality, however, and will be in a paltry 64Kbit/s.

Nowadays Napster is a legitimate music-streaming service with a catalogue of over 30 million tracks



On mobile devices most tracks can be played back at 320Kbit/s, which puts Napster in line with other services. You can also opt to play at 192Kbit/s or 64Kbit/s if data usage is a concern. Again, not all tracks are available at up to 320Kbit/s, so some might play only at 192Kbit/s or even 64Kbit/s.

Napster Unlimited Plus Mobile also allows for offline syncing so you can play music on

both PCs and mobile devices without an internet connection, which is useful. This isn't an option for the cheaper plan, however.

APPS AND MULTIROOM

The Napster app is available for iOS, Android and Windows Phone devices. Again, you'll need to subscribe to the Unlimited Plus Mobile plan for mobile playback.

In terms of multiroom speaker support, the likes of Sonos, Samsung's M range and LG's Music Flow speakers will all happily play Napster tracks around your house. There's also a Napster app for Xbox 360, but not for the current-generation consoles.

VERDICT: MUSIC-STREAMING SERVICES

Digital downloads are slowly going out of fashion as more and more of us choose the convenience that streaming provides. That doesn't mean to say it's a completely smooth transition, though. There's a lot of controversy around the low royalties being paid to artists from streaming services, for example, which means that not all the music you might want to listen to is available online at present.

Even ignoring the issue of availability, it's still hard to recommend a single service that will suit all needs and tastes. Thankfully, the good news is that most of the services offer free trials so you can take them for a test run to decide which is

best for you. Keeping that in mind, here are our recommendations.

Spotify has a good combination of music catalogue, app support and multiroom speaker support. Spotify's Sessions feature means it has plenty of great exclusive content from artists as well. It should be your first trial if you just want streamed music.

Google has made great strides since its streaming service first launched. The ability to upload up to 50,000 of your own tracks to the company's servers means you can fill in any holes in Google's music catalogue. The great thing is that this is available for free without an All Access subscription, so if you have a large digital music catalogue there's

no reason not to take advantage and have streaming access to your collection anywhere with an internet connection.

If you care about sound quality Tidal is a great choice, but you'll be paying a premium. It's worth first taking the Tidal High Fidelity Test to see if your listening equipment can even produce a discernible difference. If you happen to be a Sonos speaker owner, then Deezer Elite could be a great alternative as there's no additional cost for the higher-quality streams. Napster is the least enticing of the services available, in part due to its mixed streaming quality and the overall presentation in its apps.



TAKE CONTROL OF YOUR EMAIL

Whether it's for home use or a business, an email address on your own domain is much neater than using a free service – and it's simple to set up, too

While you get a lot with a free email account, such as those from Gmail or Microsoft, you're plagued with adverts and you get less choice over your email name. A better way is to register your own domain name and then add an email package to it. This gets you a completely custom email address and lets you expand to add more users or family members, as you want. If you're running a business, it also looks a lot more professional to have a dedicated email address than it does to be using a free one.

In this feature, we'll show you what the various options are, how you go about setting them up and what the benefits are over a free service.

Why pay for email?

The big benefit is that you get your own custom email address based on the domain that you register, such as david@mydomainname.com. In addition, you can add other email addresses as you need them, with <any name>@mydomainname.com yours to use. It means no more endlessly typing in usernames only to find that they've already been taken, as you do with free services.

Once you pay for your email, you'll no longer be swamped with adverts as you do with Google and Microsoft accounts. That's a better user experience overall, and makes sending and receiving email a lot less invasive.

In addition, if you're using the free email that comes with your ISP, you can't change

provider without losing your account. Once you've signed up for your own email address, you can switch ISP as many times as you like, keeping the same email address.

Different services

There are a few different types of email account, depending on what you want to do. With an entry-level account, you'll get a basic webmail interface, a few gigabytes of storage and the ability to connect mail clients and your mobile devices. Moving up the scale are the more advanced or business accounts. These typically cost a little more and give you the ability to synchronise your calendar and contacts with your online account, too.

At the top end is a Microsoft Exchange account. This gives you a user-friendly web interface, the option to use full Outlook with your account, plus better calendar-sharing and appointment-scheduling.

There's also the option for Google Apps, which is a paid-for version of the free Gmail services. This gives you more storage and no

E-mail Address

Select and define where incoming e-mails should be delivered to:

E-mail Account

E-mail address: @

Setup Data

Type:

First name:

Last name:

Display name:

Password:

Repeat password:

Security Settings

Anti-SPAM: ☒ Enabled

Virus scanner modules:

Virus Protection: ☒ Enable

Other Settings

1&1 Mail Business: ☒ Enable upgrade to 1&1 Mail Business

If you enable this option, the user of this 1&1 Mail Basic mailbox can perform a paid upgrade to 1&1 Mail Business. This may lead to additional costs for you as the account owner.

If you disable this option, the user of this 1&1 Mail Basic mailbox cannot upgrade to 1&1 Mail Business. The upgrade is then only possible via the 1&1 Control Panel.

For information on prices for 1&1 Mail Business, please refer to our 1&1 Shop.

Forwards

Forward:

Creating a new email user with 1&1 is simple and just requires you to fill out one simple form

Accounts

Show All

Default Account: **Computershoppertest** IMAP Account

Account description:

Personal information

Full name:

E-mail address:

Server information

User name:

Password:

Incoming server: Port:

☐ Override default port

☒ Use SSL to connect (recommended)

☐ Always use secure password

Outgoing server: Port:

☐ Override default port

☒ Use SSL to connect (recommended)

It's easy to set up a basic email account to work with your software of choice

adverts, but we haven't covered it here, as you have to make some fairly complicated changes to your domain to get it working, it's relatively expensive and quite hard to configure. It's really designed for businesses with an administrator to set everything up.

IMAP or POP3?

Before we show you how to configure your accounts, there's one important configuration consideration: should you use IMAP or POP3? When you connect to your account via POP3, the messages are downloaded from the server and, usually, deleted from it. That means that if, for example, you download your email using your laptop, when you connect from your smartphone you won't get the same messages.

IMAP is the alternative and it leaves messages on the server. More importantly, any changes you make on one device are synchronised to the server. For example, read an email on your laptop and your smartphone will show that the message has been viewed; delete an email on one device or via webmail and it's gone on everything.

IMAP requires more storage space, as you're not constantly clearing the server, but it's the much better choice if you have multiple devices on which you want to get email, plus all your messages are safe in the cloud. Note that Exchange accounts work like IMAP accounts: it's a slightly different protocol, but the basic configuration is the same.

Registering a domain name

You'll need your own domain name, such as www.computershopper.co.uk, to get started with your email account. It's easiest to register to the domain through the company that will provide the email service, as there's no additional configuration required. Domain names cost from £2.49 a year, so won't break the bank.

How to configure a basic email account

We're using 1&1's standard mail hosting for this walkthrough, although configuration steps are similar with other accounts, too. When you log in to your account, you need to click the selection to create an email account. You'll have a choice between Basic and Business; select Basic. You'll first need to enter a name for the email account and then use the drop-down menu to select the domain name you want it associated with, such as david@computershopper.co.uk. Next, fill out the details and enter a password. You can also choose to enable anti-spam and anti-virus services to keep your inbox clutter-free, and if the account

can be upgraded to a Business account. You may want to leave this option selected, so that you can take advantage of the additional Business features at a later date.

Click OK when you're done and the user will be created. You can now log in with your email and password at webmail.1and1.co.uk. The web interface is a little basic, but you'll see across the top of the screen that you've got tabs for email, calendar, contacts, a to-do list and more. Click on Email and you'll see that the layout closely resembles that of a desktop email application. It's straightforward to read email and compose new messages from this interface. If you're only going to use the web interface, then you can use the calendar and contacts section; if you want to use a desktop client, then we don't recommend this as there's no way to sync the calendar and contacts to your computer. Instead, think of this basic account as one for email only.

Setting up a desktop client, such as Windows Live Mail, is easy. You just need to enter a new standard mail account, and use the information in the table below. Note that some email clients let you add the account, but only let you adjust the required port number afterwards, so don't worry if you initially get an error. Your email address and password are required for authentication.

Advanced business accounts

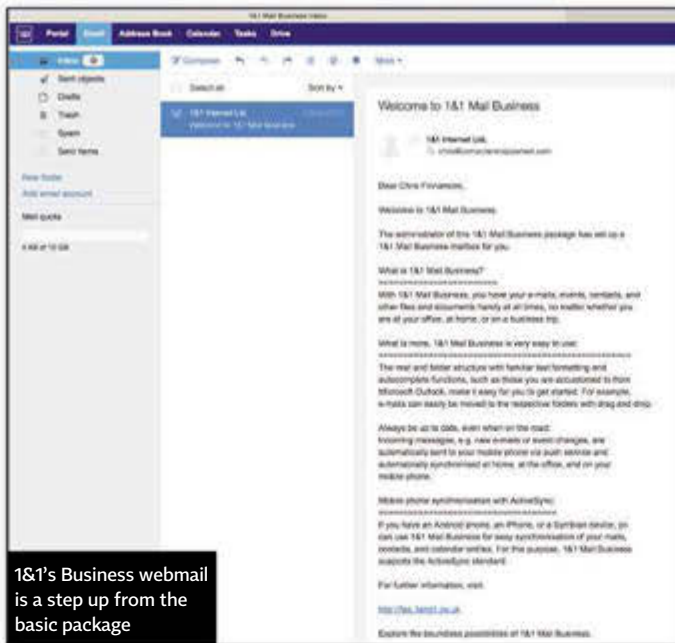
If you want a bit more from your email account, including more storage space and the ability to synchronise contacts and calendars, you need to step up to a business account. We're using 1&1's Business account here, although you'll get similar features from other providers.

First, you need to create an account. The procedure is very similar to creating a basic account, as above: select the option to create an account, then choose Business and fill out the form to create your account. Once you're done you can log into your account via webmail.1and1.co.uk, using the email address and password that you created. This time around, you'll notice that the web interface is a lot cleaner and more modern than with the basic account.

With Business mail you can use desktop clients, as well as mobile phones. We'll show you how to configure both. If you're using a PC and you want to synchronise your calendar as well as your contacts, you have a couple of options. First, if you have Outlook you can download the 1&1 MailXChange connector. Outlook can't talk to the 1&1 servers

1&1 SETUP INFORMATION

Incoming server	Port number	Outgoing server	Port number	Connection type
imap.1and1.co.uk	993	auth.smtp.1and1.co.uk	587	SSL/TLS
pop.1and1.co.uk	995	auth.smtp.1and1.co.uk	587	SSL/TLS



directly, but this bit of software does some clever automatic conversion for you. Full instructions can be found at bit.ly/OutlookConnector.

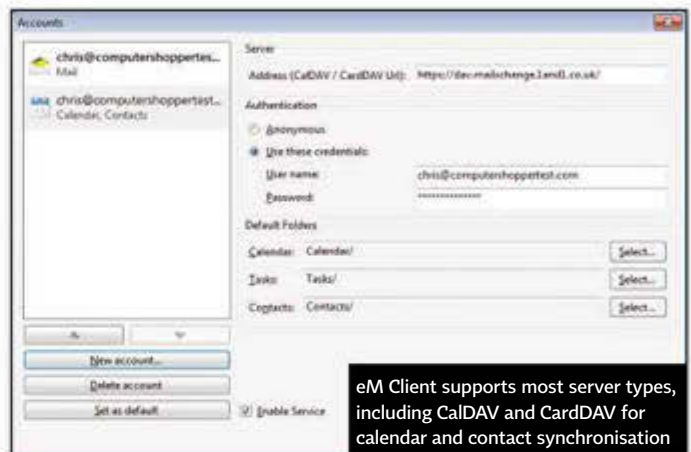
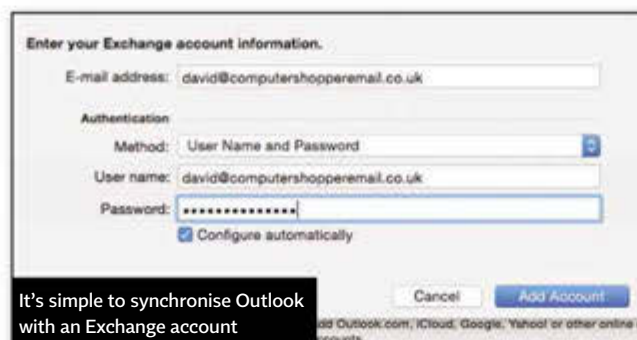
If you don't have Outlook, you can alternatively connect using CalDAV and CardDAV to access your contacts and calendar, while email is delivered by IMAP. Macs have CalDAV and CardDAV support built in. Go to System Preferences, Internet Accounts and click the '+' button. Select Add other account and choose Add a CalDAV account. Select Manual in the next dialog box, enter your 1&1 email address and password in the relevant boxes, then enter <https://dav.mailxchange.1and1.co.uk> as the server address. Repeat the above instructions exactly, except select Add a CardDAV account to synchronise your contacts. Now when you start the Calendar or Contacts apps, you'll see everything pulled in from your internet account.

If you've got a PC, you need a client that can use CalDAV and CardDAV. The best free one we've found is eM Client (www.emclient.com). Click Tools, Accounts and click Add Account. Select Calendar and choose CalDAV and click next. Enter the account address as <https://dav.mailxchange.1and1.co.uk>, the username as your 1&1 email address and your password. Click Next to confirm and your calendar account will be added. Contacts are added automatically, too.

As the Business account supports ActiveSync, getting a mobile device working is easy. In Android or iOS, just add a new account to the phone, choosing Exchange as the type. Follow the wizard, entering your 1&1 email address and password as normal, but use s.mailxchange.1and1.co.uk for the server address. Once complete, your phone will pull in your email address, calendar and contacts automatically.

Setting up an Exchange account

We used Fasthosts' Exchange service for this guide, but configuration will be similar for other hosting companies' Exchange services. Once you've logged in, click the link to create an email account, then select Exchange 2013. You'll be able to choose how many email accounts you want to create (it's cheaper the more you create), and if you want to download the latest version of Outlook (an extra £149 a month). Outlook isn't required, as the web interface does everything, but it's a good option if you want the best desktop support. Choose if you want to pay monthly or yearly and click Continue when you're ready. You'll need to select a domain name you own or buy one before continuing.



Once you have your domain name, you can add a mailbox to your account. Click Email, Manage Email Packages, then click the Email button next to your domain name. Click the Create Mailbox button and fill out the form. Your Exchange email account is now ready to go.

To access your account via the web, you just point your browser at 1.exchange2013.livemail.co.uk/owa and log in with your username and password. Once you're in you'll see a web interface that apes the desktop version of Outlook. There are separate tabs for your Calendar and Contacts (People). Cleverly, any other email accounts you've added to your domain will automatically appear in the Global Address List. If you invite them to a meeting or want to send them an email, their addresses will be completed automatically.

If you'd rather use a desktop client, then you'll need one that supports Exchange. For PCs eM Client is a good choice; if you have a Mac you can use the built-in Mail or get Outlook. Taking Outlook as our example, you need to add a new account and select Exchange. Next, enter your email address, your username (your email address) and your password. Click Add account and Outlook will go away, find all the correct server settings and automatically configure itself. You can now email, get all of your calendars and manage your contacts through your desktop client.

If you want to add your email account to your smartphone, Android and iOS devices both support Exchange auto-configuration, which means that you just need to add an Exchange account, enter your email address and password, and everything will be pulled in automatically. Now, everything you do on one device (desktop, web or mobile) will be synchronised between all your devices. ☑



HOW **BAD** ARE UNOFFICIAL DOWNLOAD SITES?

Adverts on the Bing search engine point to dubious download sites that could fill your computer with malicious software, as our exclusive investigation reveals

Computer Shopper has discovered that Microsoft's Bing search engine is displaying prominent links to download sites offering bloatware-stuffed versions of free software, including its own Internet Explorer web browser.

These download sites appear in search results by buying advertising based on keywords. As Bing displays advertising at the top of the page, these sites appear higher up than the product's official page, which could fool users into going to the wrong site. Users are prompted to download a custom installer, which also attempts to install additional software, including adware, ad injectors and other potentially unwanted software.

This kind of behaviour falls into a grey area. Technically, it's not malware as the

software asks permission to install and doesn't directly affect your computer, which is why security software rarely picks it up. However, that doesn't mean it's not a problem.

For starters, the opt-out options are often hard to spot, and it's easy for users to click Next in a wizard and 'allow' additional software on to their PC. Second, this kind of additional software is bloatware, sucking up resources and disk space. Third, ad injectors are not only annoying, shovelling adverts into every website you look at, but they can also break websites and stop them rendering. Finally, there's the risk of a security flaw being uncovered, as with Lenovo and Superfish.

During our testing, we found one bit of 'harmless' software we downloaded opened up a new website that had a pop-up warning

us that our computer had a virus. After calling the number on the site, our test PC was soon under the remote control of scammers who demanded £89 to 'clean' our computer. It's exactly this sort of attack Microsoft has warned about in the past.

Google has taken a tough stance on this kind of dubious practice, and is disabling sponsored links to websites that bundle unwanted software with free downloads. Sadly, Bing has yet to take this approach.

Bing's search results also have a sidebar on the right of the screen that sometimes shows a link to official download sites, but this isn't always obvious or even present.

DANGEROUS LINKS

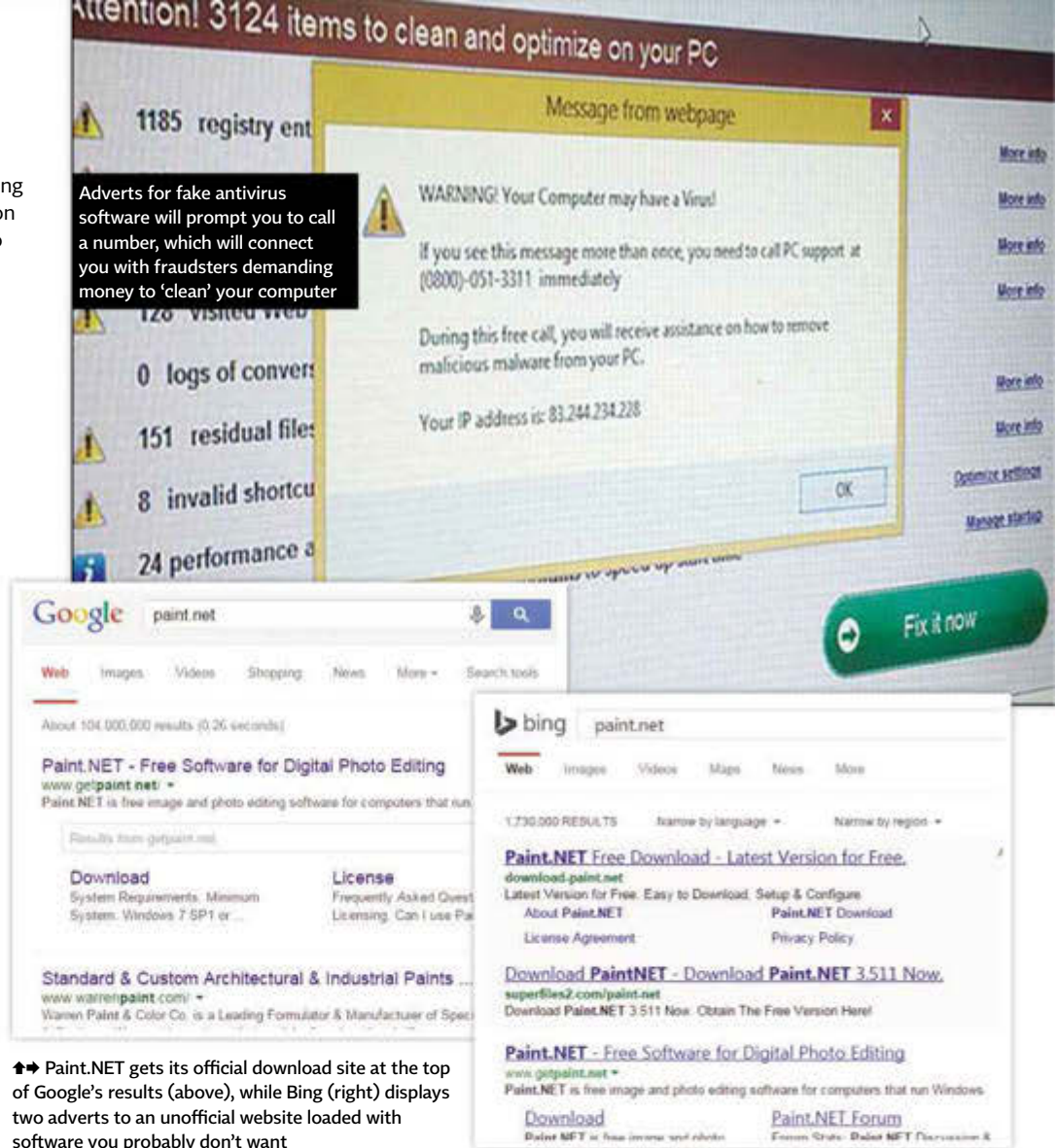
We decided to find out just how bad the problem is on Bing. First, we went to *ninite.com* to put together a list of our favourite bits of free software, including Chrome, Firefox, Spotify and Paint.NET. We picked this site, as its own custom installers are guaranteed not to install toolbars or other junk bits of software.

Next, we searched for each application in Bing and noted if the top download site was official or unofficial. If it was official but was in the ad box – in other words, the manufacturer has had to pay to be top of search results – we've noted that, too. If there was an unofficial download site, we downloaded the installer and took note of the extra software that we were asked to install. Finally, we downloaded the official installer directly from the manufacturer and did the same thing. You can see the full results in the table on the following page.

Six out of ten pieces of software were affected by unofficial sites locking out the top of Bing's search results. All six unofficial download sites provided installers that promoted additional, potentially unwanted software including adware, PC cleaning programs, security software and toolbars. By comparison, using the same search terms on Google yielded 10 official download sites.

None of the installers alone was detected as potentially unwanted, although once we began clicking 'Accept' on each of the offers, our security program, Kaspersky Anti-virus,

Adverts for fake antivirus software will prompt you to call a number, which will connect you with fraudsters demanding money to 'clean' your computer



➡ Paint.NET gets its official download site at the top of Google's results (above), while Bing (right) displays two adverts to an unofficial website loaded with software you probably don't want

threw up warnings that we were installing potentially unwanted software.

We also checked the official websites of each piece of software to see how much – and what type of – additional software the official installers offered to the users. These mostly consisted of toolbars and search engine switches to one of the major providers such as Google, Bing, Yahoo and Ask, although one official installer from SourceForge contained Linkey, a piece of adware.

REACTION

Simon Edwards, technical director of Dennis Technology Labs, which conducts quarterly internet

"There's so much money in this industry, it's going to take quite a lot to stop people pushing around the edges of legitimacy," said Edwards. "Search engines and security software can crack down on the 'potentially unwanted software' that users neither want nor need. However, in response to this, the firms that rely on distributing that software to make an income are likely to become more aggressive.

"If and when Bing stops showing those links the distributors have a choice: go out of business or be more subtle. They could turn completely legitimate, but time will tell."

David Emm, principal security researcher at Kaspersky Lab, told *Computer Shopper*



➡ An ironic piece of potentially unwanted software from our tests

Our PC was soon under the control of scammers who demanded £89 to 'clean' our computer

security stress tests and provides the data used in *Computer Shopper's* antivirus reviews, explained that the business of preloaded software is extremely complex.

that while such links may appear misleading, any given search engine provider will likely have carried out security checks before approving advertisements.

"Clearly it's in their interest to do this thoroughly, since if it turns out that their

BAD SECURITY SOFTWARE UNDER THE MICROSCOPE

To find out how bad the available download sites are, we searched for some of the most popular free software online on both Bing and Google. In all cases we noted down what the top download link was and if it was official or not. We've also noted if the manufacturer has had to pay for the top link. Where an unofficial download site was listed, we visited it and downloaded the custom installer, making a

note of which additional software it attempted to install on our computer. We then downloaded the official installer from the software manufacturer and noted down any additional optional pieces of software. You can see these results in the table, and in the box below you'll find a list of the software that we found and an explanation of what it actually does.

Application	Bing top download result	Google top download result	Unofficial additional software	Official additional software
Google Chrome	Unofficial	Official	Yahoo! search and homepage, Dregol adware, Browse Pulse adware, mystartsearch toolbar	None
Internet Explorer	Unofficial	Official	Dregol adware, Assist Point adware	None
Mozilla Firefox	Unofficial	Official	Ad-Aware, MyPCBackup software, Roaming Rate adware, Super Optimizer software, Driver Assist software	None
Skype	Official	Official	N/A	Bing default search engine, MSN homepage
FileZilla	Official	Official	N/A	Mystartsearch toolbar, Linkey adware
iTunes	Unofficial	Official	Dregol adware, Yahoo! search and homepage	None
Spotify	Official	Official	N/A	None
Java	Unofficial	Official	None	Ask toolbar, homepage, search
7-Zip	Official	Official	N/A	None
Paint.NET	Unofficial	Official	Yahoo! search and homepage, mystartsearch toolbar	None
OpenOffice	Unofficial	Official	SafeSearch security/adware, Crime Watch adware, Premier Opinion surveys, Optimizer Pro software	None
Avast	Official (paid ad)	Official	None	Google toolbar for IE

advertised links do harm, their reputation could be seriously damaged," said Emm.

We contacted Microsoft to get its take on the situation. The company wouldn't comment directly on our research but a spokesperson stated that it takes fraudulent advertising "very seriously".

"We have an extensive process for filtering and monitoring Bing traffic against known fraudulent patterns to help detect and prevent against fraud and phishing techniques," a Microsoft spokesperson said. "We are dedicated to providing a trusted and reliable search experience for consumers and effective search advertising platform for our brand partners."

The company said users should report any concerns via the Bing reporting tool.

HOW CAN YOU AVOID PROBLEMS?

First, it's important to go directly to the manufacturer's website and follow its links for where to download its software. That way you'll avoid a lot of the pitfalls. As we discovered, some manufacturers also try to make you install additional toolbars and other junk software, so it's worth starting with Ninite, which will enable you to install spyware-free software.

Finally, make sure that you're running up-to-date security software to block anything that's particularly. Our guide to the best internet security software (see *Shopper*

WHAT THE APPLICATIONS ACTUALLY DO

Once we'd got a list of the additional software, we also found out what it did, and you can find the results in the table on the right. First a quick explanation of the 'Function' column. An ad injector is software that puts its ads into websites automatically; a news injector does the same thing, but puts in links to headlines; a search toolbar puts a new search bar into your browser, with searches performed in the matching search engine; driver and software updaters charge you to find outdated software and update them; cleaners try to charge you to fix problems they've discovered; and surveys try to make you fill out questionnaires.

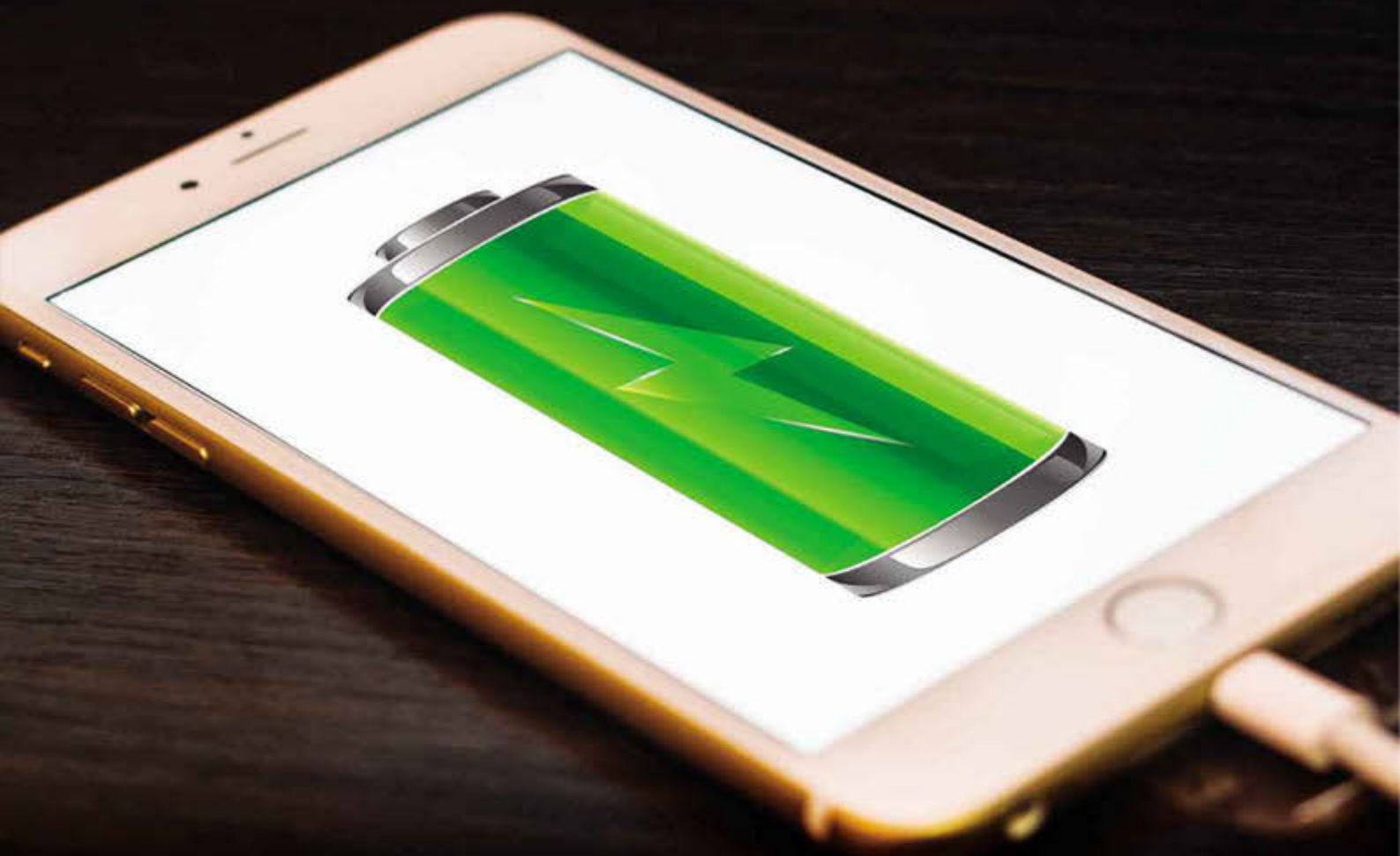
324) will help you find the best paid-for and free software to keep yourself protected.

VERDICT

The additional software you can get from third-party installers and, in some cases, the original installer, may not count as malware, but it's still a big problem. This kind of software only exists to make its developers

Application	Function
Ad-aware	Security software
Ask toolbar	Search toolbar
Assist Point	Ad injector
Browse Pulse	Ad injector
Crime Watch	News and ad injector
Dregol	Ad injector and search engine
Driver Assist	Paid-for driver updater
Google toolbar	Search toolbar
Linkey	Ad injector
MyPCBackup	Backup software
Mystartsearch	Toolbar and homepage
Optimizer Pro	Paid-for PC cleaner
Premier Opinion	Surveys
Roaming Rate	Ad injector
SafeSearch	Toolbar and search engine
Super Optimizer	Paid-for PC cleaner

money and they do so in some horrible ways, affecting how you use your computer. Just as bloatware on a PC is a bad thing, so any additional software outside of the application you want to download is also unwelcome. It's our belief that search engines should clamp down on this kind of behaviour, block all adverts for these kinds of sites and refuse to rank them in regular search results. ☹



Charge faster

A guide to more efficient USB charging

Why does it take forever to charge an iPad with an iPhone charger? We explain all

While the humble USB port, or Universal Serial Bus to use its full name, has been with us for decades, it's only in recent years that it has become the default option for supplying our gadgets with power. Whether it's a tablet, smartphone or portable media player, charging our devices is much simpler than it used to be. Now, with the new MacBook (see page 24), USB charging is coming to laptops, too.

USB power can be supplied from a number of sources, such as the USB ports on your PC or even your TV. Then there are innumerable USB adaptors that most of us

have hogging our sockets around our home, many of which came with old devices that are long forgotten. Not all these USB ports and adaptors are created equal, though, and not all devices require the same power draw.

This means that a high draw device, such as a tablet, might not charge from the USB port on your computer, or it might charge extremely slowly using the charger supplied with your smartphone. The reason behind this is largely a matter of amperage.

Power sources and adaptors

The main difference between USB charging sources, be they ports or wall adaptors, is the

amount of amperage and voltage supplied. The supplied iPhone USB wall adaptor, for example, is rated at outputting 5V and 1A. The charger for the iPad provides 5.1V and 2.1A, due in part to the iPad's larger battery. Then there are other fast-charging standards such as Qualcomm's Quick Charge, which works with a number of smartphones using specific Snapdragon processors. Quick Charge can output up to 9V/2A, providing a charge up to 75% faster than a 5V/2A charger, so your battery fills up far quicker.

A standard USB port on a computer typically outputs far less power. A USB port can be rated as low as 500mA (0.5A),



whereas a USB3 port can output up to 900mA (0.9A), both providing 5V. These are the standard ratings, however, and some motherboard manufacturers might include special features designed for faster charging or charging high-draw devices, and these can provide upwards of 1.5A. Asus's Ai Charger, for example, can enable up to 1.2A over the USB ports, whereas certain USB ports on an MSI motherboard can support its Super Charger function. Certain motherboards will even allow you to continue charging over USB even when the system is shut down or in sleep mode.

USB hubs can be a bit of a mixed bag. Even hubs that have a separate power adaptor, meaning they need to be plugged into a wall socket, might only provide the standard 500mA from each USB port. Alternatively, only one of the ports might provide a higher amperage. You'll need to check the hub's specifications and documentation to be sure. Then there are also portable battery chargers (sometimes called 'power banks'). Many will have two USB ports, with one rated 1A and the other at 2A. As you would expect, you'll get faster



Wireless charging removes the inconvenience of cables

Wireless charging

It's now possible to do away with the need to connect wires through wireless charging. The most popular wireless charging standard (also known as inductive charging) is the Qi standard (pronounced 'chi'). Compatible smartphones and tablets are available from

Intel is a member of A4WP and has confirmed that it expects laptops that support the wireless charging standard to appear within a year, which means your desks can finally be free of some of the clutter of cables. The Rezence charging pad can work through reasonably thick surfaces as well, meaning it will be far easier to create a DIY wireless charging surface simply by mounting the charging pad to the underside of a table or desk.

Intel expects laptops that support wireless charging to appear soon

charging from the 2A port, so prioritise using that and use the 1A port for when you need to charge two devices simultaneously.

The device you're looking to charge and how much power it's designed to draw will also affect charging speeds. Connecting a tablet that is designed to handle 5V/1.5A to a 5V/2A USB adaptor won't make it charge faster than it can safely handle.

Flatpack wireless charging

You know wireless charging is becoming mainstream when Ikea offers furniture with built-in Qi wireless charging. The famous Swedish furniture retailer now sells everything from lamps to desks and bedside tables with integrated chargers, as well as standalone chargers. You can also buy kits to integrate them with your existing furniture using a special drill bit to cut away a suitable hole to fit the charger, meaning you never have to be too far from a wireless charging surface.

If your smartphone doesn't support wireless charging, Ikea (and other third parties) sell special cases that add wireless charging functionality to a number of popular smartphones, including the iPhone.

LG, Samsung, Nokia, Motorola and Sony. There's also a rival standard known as Rezence from A4WP (Alliance for Wireless Power). A4WP will soon be merging with the Power Matters Alliance (PMA) to create a stronger competing standard to Qi.

Wireless chargers typically consist of a wired charging pad, on which you place the device you want to charge. It's faster and more convenient than having to connect a cable to your device. The same power principles apply to wired charging devices as with wireless chargers in that they can provide different wattages.

The 'low power' Qi specification provides up to 5W of power. Chargers such as the optional Google Nexus Wireless Charger can provide 9W at 5V/1.8A. This should charge a Nexus 5 faster than its included USB wall adaptor, which is only rated at 1.2A. There are also medium power (120W) and forthcoming high power (1kW) specifications, although the latter is designed for high-power utilities such as kitchen equipment.

Rezence technology is an exciting prospect as it uses magnetic resonance rather than inductive charging, which requires some intricate lining up of your device and the pad to ensure charging occurs. Rezence is far more forgiving when it comes to placement. It will also be a technology worth keeping an eye on, as its specification will allow for up to 50W, meaning it has the capacity to charge and power laptop computers.

Why does my iPad take so long to charge?

Calculating what different wattages mean largely comes down to maths. We've used an iPad as an illustration of how charging times can be affected:

	CURRENT	VOLTAGE	WATTAGE	TIME
USB port	500mA	5V	2.5W	24:00
iPhone charger	1A	5V	5W	12:00
iPad charger	2.1A	5.1V	12W	5:00

As you can see, using the supplied higher-wattage iPad charger is going to be the optimal way of charging your iPad. Using a PC's USB port will take a very long time indeed, while an iPhone charger will get you there but will take more than twice as long.

However, while the iPhone charger is rated at providing 5W, in testing using a wattmeter we were actually only able to get a 3.7W power draw while charging the iPad with the tablet turned off. This will also contribute to a slow charge speed. With the iPad turned on it began drawing 6.7W of power, but this doesn't mean it will charge faster as some of the additional power will be used to actually power the iPad without also charging the battery.

In contrast, while charging using the iPad's 12W charger, it managed to draw 12.7W both with the iPad turned on and turned off. The other interesting thing we found was that you'll want to specifically use the iPad's 12W charger to get faster charging for your iPad. A similarly rated

adaptor might not get the same charging speeds. For example, using a 5.2V/2.1A charger from an Nvidia Shield Tablet, which should have a slightly higher wattage than the iPad's adaptor, the iPad behaved in the same way as if it were connected to an iPhone USB adaptor, drawing 6.7W when powered on and 3.6W when powered off, meaning charging time is almost doubled.

Connecting an iPad to a PC, on the other hand, will result in the iPad reporting it's not charging when the screen is on. With the screen off, it will actually charge, albeit incredibly slowly. You'll also want to turn the iPad off entirely to help speed up the process, but you'll need a lot of patience.

How much does it cost to charge an iPad?

The cost of charging your device doesn't fluctuate based on the charger you use. Using the iPad as an example, the US-based Electric Power Research Institute found that the average cost of charging an iPad was \$1.36 (about 90p) a year. The research also found that this cost won't be affected by the charger you use, as everything is scaled. A higher wattage requires less time and a lower wattage requires more time, so it averages out to the same cost.

Is wireless charging slower than using a wire?

We tested charging a Nexus 5 using a wireless Qi charger as well as using a 5V/1A USB adaptor, and the results were pretty close. Using a wired USB cable and adaptor the Nexus 5 drew 5.3W, whereas with the Qi charger it drew 4.8W. Wireless charging will be slightly slower but not by a great deal and certainly not enough to negate the convenience of not having to connect a cable every time you want to charge your device.



Even a lamp can be used to charge your devices and help remove clutter from your desk

Can I blow up my device?

A common fear with such discrepancies in output power is that you might cause your device's battery to explode or become damaged. However, this isn't likely with modern devices. If you plug a low-draw device, such as an iPhone, into a high output USB adaptor such as the iPad's, nothing bad will happen. If anything, the iPhone might charge slightly faster than if you were to use its standard charger if it's capable of slightly higher energy draw. A device won't draw more than it's capable of handling.

If you have multiple USB wall adaptors around the house, it will therefore be most efficient to prioritise using the 2A chargers if you need to charge things more rapidly. However, be warned that voltage differences in the power outlets between countries could still damage your electronics if your device doesn't have a voltage transformer or you don't use a separate transformer.

Type-C: the future of USB charging


Until recently, the design of a USB port had remained largely stagnant since its introduction in 1996. Smaller connections, such as Micro USB and Mini USB, were introduced to accommodate the diminutive size of many consumer devices, and there's also USB Type-B, which is commonly used on printers, but the cables still typically all terminate in a full-size USB Type-A connection on the other end.

Having such an array of connection types for consumers can be a little annoying, as you might find your smartphone uses a Micro USB cable whereas your action camera uses Mini USB, meaning you always need to carry two separate cables.



↑ Reversible USB Type-C means you'll never insert a cable the wrong way again

USB Type-C changes all of this. It's a new standard that has a reversible Type-C connector on both ends, meaning there's no way to insert it 'upside down'. It can be used for a wide range of purposes, including data transfer, video output and, most importantly for the purpose of this article, charging.

Its power output capabilities are far higher than the old USB specifications as it's designed to power extremely high-draw devices such as laptops, including Apple's new MacBook and Google's Chromebook Pixel. This means it can support up to a staggering 100 watts of power (5V/20A). It's undoubtedly a technology worth keeping an eye on as it becomes more prevalent. 



Ikea's furniture can be modified to add Qi wireless charging



ARE YOU PAYING
TOO MUCH
FOR YOUR PHONE?

Paying for your smartphone on a contract may be easier, but it could be costing you far too much. We find out if you're better off going SIM-only

While most technology seems to go down in price, smartphones are one area where we've steadily been paying more and more, both on the devices and on the contracts that go with them. It doesn't help that there's often a confusing array of contracts and buying options, making the decision even harder.

In effect, there are two main methods of buying a smartphone. First, you can buy one on contract, where you're locked in for a set amount of time and pay off your handset at the same time as paying for the service you use. Second, you can buy a phone outright and choose a SIM-only contract or use pay-as-you-go. The question is, which method is best and which one should you go for?

Figures from Which?'s Unlock Better Mobile Deals campaign have shown that Britons with mobile phone contracts are, on average, paying £92 more than they need to for their smartphones. The research showed that £355 million is collectively being wasted by consumers who fail to renegotiate their contract once the duration of their contract is met – usually 24 months.

The reason it's important to renegotiate your contract is that the cost of the handset is incorporated into your monthly bill, so you spread the cost of the handset over time. This means you have a considerably smaller up-front cost for the handset, with many contracts coming with 'free' phones, but pay over the odds at the end of your two-year stint. In effect, you're paying again for something that you've already bought.

It's not difficult to see why this might happen. Two years is a long time, and you hardly need to be an absent-minded type to forget the end date of your contract. Many service providers don't always make it clear you've fulfilled your contract obligation, either. At the other end of spectrum, some operators, such as O2 with its O2 Refresh package, should be applauded for clearly separating the cost of the handset and the tariff, so once you've paid off the handset you're only left paying for the tariff. However, this is the exception rather than the rule.

With all mobile phone contracts, once the handset cost is paid off at the end of your contract, you're free to switch to a cheaper SIM-only contract, get a new handset on a new two-year contract, or even sell your old

handset and use the cash to pay towards a new handset. Here we look at all the options, by taking into account the bottom line – the total cost of ownership (TCO) of your mobile phone and contract – and giving you some straightforward advice on how to lower it.

Contract vs SIM-only





One of the benefits of opting for a 24-month contract is avoiding a massive outlay for the handset. Smartphones these days can cost a lot of money, after all. However, doing so increases the TCO over paying for a phone outright and then opting for a SIM-only tariff. We've looked at the iPhone 6, iPhone 6 Plus, Samsung Galaxy S6 and Samsung Galaxy S6 Edge, four of the best and most popular smartphones available today, and compared contract prices from the four big network operators with paying for a phone outright and going for a GiffGaff SIM-only deal.

We've tried to find as close a like-for-like comparison as we could between the different tariffs available, aiming for at least 2GB of data. At this level, most tariffs will then give you unlimited calls and texts on top.

If you compare the total cost after 24 months with a SIM-only deal you can see in the table on page 126 that you can save a significant amount of money. However, note that GiffGaff offers only 500 minutes, which is less than the contract tariffs. Most people probably don't use anywhere near this number of minutes, especially in light of other communication methods such as WhatsApp.

We've used the up-front cost from GiffGaff for all of the phones bar the Samsung Galaxy S6 Edge, where the price is cheaper at Expansys. With a handset from GiffGaff you have to buy at least one month of service, but considering we've used it as an example

CONTRACT PRICES

	Supplier	Mins	Texts	Data	Up-front cost	Monthly contract	Total cost (24 months)
 iPhone 6	EE	Unlimited	Unlimited	2GB	£10	£47	£1,138
	O2	Unlimited	Unlimited	3GB	£30	£46	£1,134
	Three	600	Unlimited	2GB	£49	£41	£1,033
	Vodafone	Unlimited	Unlimited	2GB	£49	£44	£1,105
 iPhone 6 Plus	EE	Unlimited	Unlimited	2GB	£70	£47	£1,198
	O2	Unlimited	Unlimited	3GB	£110	£46	£1,214
	Three	600	Unlimited	2GB	£49	£47	£1,177
	Vodafone	Unlimited	Unlimited	2GB	£49	£49	£1,225
 Samsung Galaxy S6	EE	Unlimited	Unlimited	2GB	£70	£42	£1,078
	O2 (free Fitbit Charge)	Unlimited	Unlimited	3GB	£70	£41	£1,054
	O2 (free Fitbit Charge)	Unlimited	Unlimited	3GB	£650	£21	£1,154
	Three	Unlimited	Unlimited	2GB	£49	£42	£1,057
	Vodafone	Unlimited	Unlimited	2GB	£0	£44	£1,056
 Samsung Galaxy S6 Edge	EE	Unlimited	Unlimited	2GB	£150	£48.50	£1,314
	O2 (free Fitbit Charge)	Unlimited	Unlimited	3GB	£90	£51	£1,314
	O2 (free Fitbit Charge)	Unlimited	Unlimited	3GB	£10	£56	£1,354
	Three	Unlimited	Unlimited	2GB	£49	£50	£1,249
	Vodafone	Unlimited	Unlimited	2GB	£49	£49	£1,225

CONTRACT-FREE PRICES

Phone	Supplier	Mins	Texts	Data	Up-front cost	Monthly tariff	Total cost (24 months)
iPhone 6	GiffGaff	500	Unlimited	3GB	£499	£15	£859
iPhone 6 Plus	GiffGaff	500	Unlimited	3GB	£579	£15	£939
Samsung Galaxy S6	GiffGaff	500	Unlimited	3GB	£549	£15	£909
Samsung Galaxy S6 Edge	Expansys	500	Unlimited	3GB	£695	£15	£1,055

SIM-only price, it's a moot point. As you can see from the above table, in some cases you can save nearly £300 across a period of 24 months, which is a sizable sum. Now consider those who continue beyond their 24-month contract and the potential price discrepancy becomes even more substantial. While we've used GiffGaff as a reference point, the same holds true with the main networks. With EE, for example, if you pay for an iPhone 6 Plus up front and get a SIM-only deal for £16 a month, your TCO is £963: a saving of £115.

Further advantages

There are several other advantages to buying your own handset. For a start, the smartphone will be completely unlocked, so

Selling your smartphone after two years will bring down the total cost of ownership even further and help you to fund an upgrade

you can install any SIM in it. This advantage can be handy when travelling in order to save money. For example, if you're going to a country that supports Three's Feel At Home service, where your local minutes and data can be used abroad at no additional cost, you can switch your regular SIM for a Three pay-as-you-go (PAYG) version. Alternatively, you can buy a local SIM in the country you're visiting and save money that way.

What's more, SIM-only contracts aren't only cheaper, they're generally also shorter, with just one-year to sign up for. This gives you more flexibility and ties you into a network for less time. Finally, you can of course opt for a PAYG SIM instead at any point and then just start paying for what you use without being tied into a contract at all.

Selling your old phone

If you've had your smartphone for two or more years, you might well be itching to upgrade. Selling your smartphone after two years will bring down the total cost of ownership even further and help you to fund an upgrade. This could be after you've completely paid off your contract phone or if you originally bought the handset outright. Except for phones bought through Three, handsets you buy from a mobile network are locked to that network. You'll get the best price if you unlock your phone, which is easy.

Three's roaming deal is so good that it's often worth buying a PAYG SIM for travelling

Sorry for all the sunsets.

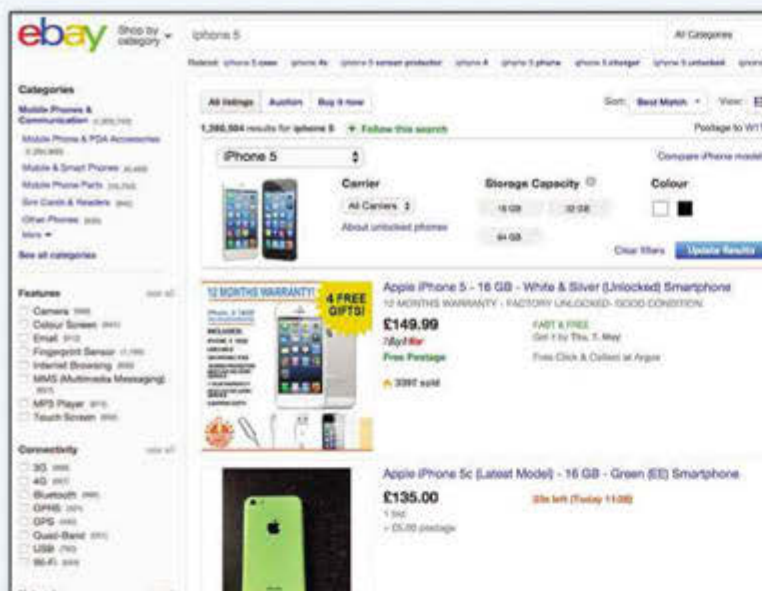
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Selling your old phone can get you a good deal of money towards a new handset

We've looked at the resale value of the iPhone 5, Samsung Galaxy S4 and the HTC One M7, all immensely popular smartphones that first appeared around two years ago to see what their resale value is now against if you were to have bought them outright. We've also explored a few older handsets for comparison, too. Keep in mind the quoted prices below are for good condition phones – you might get significantly less for an iPhone 5 that became intimate with the pavement one too many times, for example.

The iPhone 5 launched at £529 contract-free two years ago, the Samsung Galaxy S4 set you back £600 (although retail prices

quickly fell after launch) and the HTC One M7 cost around £510. Unsurprisingly, we found that selling your smartphone yourself on eBay will net you the best price. Keep in mind these are just the average prices we've seen the handsets selling for recently and they're before eBay takes its fees (usually 10%). Of the three more recent handsets, Apple's iPhone 5 retained its value slightly better than the alternatives.

Verdict

Our investigations clearly show that the best way to keep the total cost of ownership down on a shiny new smartphone is to buy it





outright and go for a SIM-only (or pay-as-you-go) deal. Then, once you want to upgrade, you can sell your old handset on and put the cash towards funding an upgrade.

As an example of a worst-case scenario: if you'd signed up to an Apple iPhone 5 contract two years ago, paying £10 up front for the handset and then £47 a month for 24 months, you would have paid out £1,138, which is already considerably more than if you had bought the handset outright and gone SIM-only. But then if you had compounded the issue further by forgetting to renegotiate your contract for three additional months, you would have now paid out £1,279.

If you had bought the iPhone 5 outright for £529 and then paid £15 a month for a SIM-only GiffGaff deal, you would have paid just £939. In the interest of fairness, we'll add three additional months of GiffGaff to make a like-for-like 27-month comparison, which gets you to £984. This means the difference between the two is a whopping £295: almost half the cost of a new handset.

Of course, the high initial outlay for an expensive smartphone isn't for everyone, and some people will prefer to pay in installments across a contract. However, if you've just got to the end of a contract, don't forget to look into the second-hand value of your current phone once you've had it unlocked, as it may go a good way towards your new handset. The important thing is to keep an eye on your contract anniversary date to make sure you don't end up paying even more than you need to. ☑

CURRENT RESALE VALUES

	Smartphone	Value	Price depreciation
	iPhone 5 16GB	£96	-£433
	Samsung Galaxy S4	£83	-£517
	HTC One (M7)	£62	-£448
	iPhone 4S 16GB	£51	-£449
	Samsung Galaxy S3	£46	-£444
	iPhone 5 16GB	£105	-£424
	Samsung Galaxy S4	£87	-£513
	HTC One (M7)	£65	-£445
	iPhone 4S 16GB	£65	-£435
	Samsung Galaxy S3	£48	-£442
	iPhone 5 16GB	£96	-£433
	Samsung Galaxy S4	£96	-£504
	HTC One (M7)	£87	-£423
	iPhone 4S 16GB	£72	-£428
	Samsung Galaxy S3	£70	-£430
	iPhone 5 16GB	£150	-£379
	Samsung Galaxy S4	£140	-£460
	HTC One (M7)	£110	-£400
	iPhone 4S 16GB	£80	-£420
	Samsung Galaxy S3	£75	-£425

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How to...

Use Continuity with iOS 8

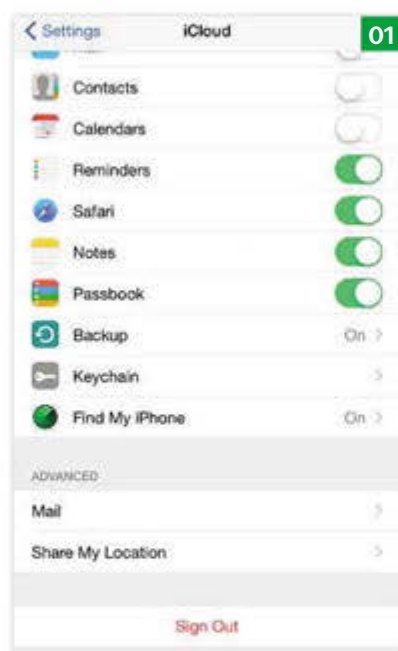
Got more than one Apple device? You can make and receive phone calls on all your iOS 8 devices using the Continuity feature. **David Ludlow** shows you how

WITH iOS 8, one of Apple's goals was to integrate all its products more tightly, so that they can use and share features between them. As a whole, this set of features is called Continuity, and the innovation that most people will probably appreciate is the ability to make and receive phone calls from any device.

The feature only works with OS X Yosemite, and iOS 8.2 has extended support to SMS messages as well, so you can send and receive texts from iOS 8 and OS X Yosemite devices. This latter feature is fairly straightforward to use, so we'll focus on how to use Continuity for phone calls.

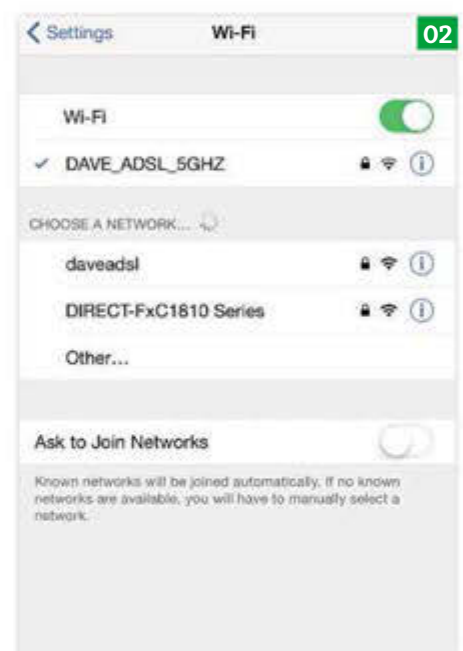
01 SIGN ALL YOUR DEVICES INTO iCloud

The first and most important requirement for Continuity is that you're signed into the same iCloud account for all your devices. You can check by going to Settings, General, iCloud. If you're not signed in, tap the Sign In button and enter your account details. If you're signed in to the wrong account, tap Sign Out and then sign in with the correct details.



02 JOIN THE SAME WI-FI NETWORK

Your devices must also be connected to the same Wi-Fi network. This is so that Continuity phone calls work only with devices that are within reach of each other. After all, having your iPad ring at home when you're at work isn't particularly useful.



03 RECEIVING CALLS WORKS AUTOMATICALLY

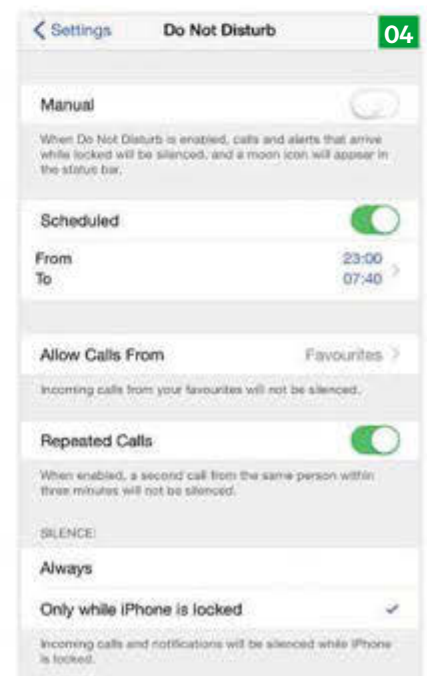
The great thing about Continuity is that it's completely seamless and works immediately. So when someone calls your phone, your iPad (or other iOS device) will ring automatically. You can pick up a call from any device by tapping the Accept button. When answering, your iOS device will switch to the most appropriate mode for the call: your iPad, for example, will answer in hands-free mode. Calls such as this are sent from your phone to your other device over your home network, so there's a small delay.

If you want to switch to your phone, just pick up your iPhone and tap the green 'Touch to return to call' bar at the top of the screen. You'll now be able to use your phone as normal.



04 MANAGING DO NOT DISTURB

Do Not Disturb is a great feature that lets you leave your phone on, muting calls and texts. All devices obey the Do Not Disturb rules that you set on your iPhone, so if you get a call in the middle of the night, your iPad won't ring if your phone's set to silent. Any callers that you manually set to allow through Do Not Disturb override the rules. Similarly, if you leave the default 'Only while the iPhone is locked' option, your iPad will ring if your phone is unlocked.





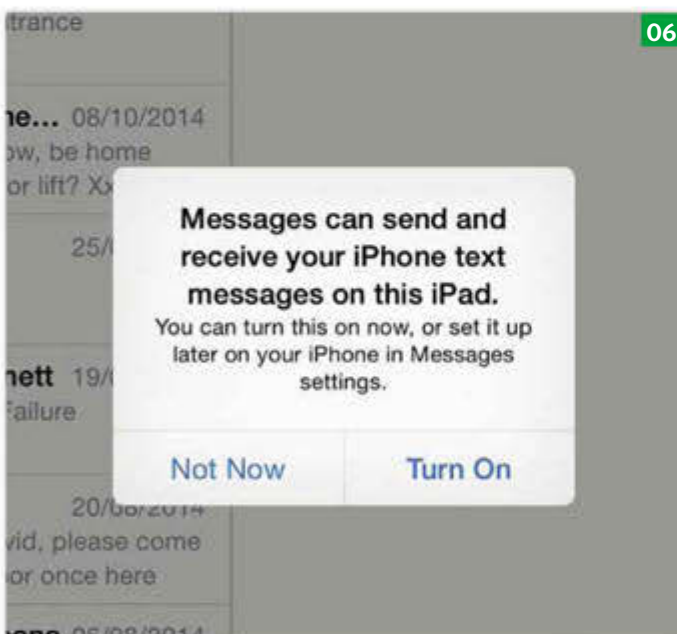
05 MAKING A PHONE CALL

If you want to make a normal phone call from another device, just open the FaceTime app. You can use the Video or Audio option; it doesn't matter which. Enter the phone number you want to call (you can also search contacts on your device), tap the phone icon, then select your iPhone from the dialog box. Your phone call will be made via your iPhone. If you want to move to your phone, you can tap the Green bar at the top of the screen to take over the phone call.



07 HOW TO TURN CONTINUITY PHONE CALLS OFF

If you don't want to use this option on one of your devices, go to Settings, FaceTime and turn off iPhone Mobile Calls. Continuity phone calls will be disabled on this device until you re-enable it. Note that all your other devices will continue to work as normal.



06 TURN ON TEXT MESSAGES

Apple devices running iOS 8 or OS X Yosemite can also send and receive messages via your iPhone. Unlike with phone calls, your devices don't have to be on the same network, as your iPhone will upload incoming SMS messages to the cloud, so that all your devices can receive them. When you send an SMS, it's uploaded to the cloud, where your iPhone picks it up and transmits it via its mobile network.

Just start the Messages app on any of your Apple devices and you'll see a pop-up message asking if you want to enable sending and receiving text messages on this device. Select Turn On. You'll see a new window with a code in it, which you must enter on your iPhone, tapping Allow to give the new device access to your SMS messages. If you don't see the pop-up message, follow Step 8 to force the prompt.

You can now send and receive all standard text messages on that Apple device; repeat for all the devices you want to have access.

Apple devices running iOS 8 or OS X Yosemite can also send and receive messages via your iPhone



08 DISABLE MESSAGES ON A DEVICE

To stop a device sending and receiving messages, go to your iPhone and select Settings, Messages, Text Message Forwarding. Use the slider switches to choose the devices on which you want to enable messages. To re-enable a device, just turn the slider back on. This will display a message containing a code on the device; enter that code on your iPhone to turn on messaging again.

Business Help

If you have database, office application or macro issues, **Kay Ewbank** can help. Send your problems to businesshelp@computershopper.co.uk



Change colour of chapters in Word

Q My father has a Word document, where he's numbered all the chapters and paragraphs so they're easy to refer to when he's discussing the material with other members of the family. His eyesight isn't what it used to be, so I'd like to highlight the paragraph numbers by changing them all to red. I also want to do some other layout changes, such as centring chapter headings and getting rid of the extra lines my dad typed in after each paragraph.

I know I could go through and do all these operations on each individual occurrence, but is there a way to do a one-off find and replace for the chapter headings, another for the extra lines, and another for the paragraph numbers? I'm using Word 2010.

Josie Anderson

A All the changes are possible, but we suggest you make sure you try them out on a copy of the document rather than the original in case things go wrong. Changing the formatting of the chapter headings is feasible, although it has the potential problem that the technique given would centre the formatting of any paragraphs containing the word Chapter (such as this one, for example).

Because of this, we'd actually just do the formatting of the chapter headings one at a time. However, if you want to do it as a one-off operation, this is how to do it. On the Home tab of the Word ribbon, click on Replace. In the dialog that appears, type the word Chapter. You can set the colour and any formatting options such as bold by clicking the Format button, then clicking Font. To centre the text, what you need to do is to enter ^& in the box labelled 'Replace with'. This is Word's special character combination that means 'contents of the "Find what" box'. You also need to press Ctrl and the E key, which is Word's shortcut key combination for centring text. Click Replace All and the chapter titles should all be centred.

Next on the list are the extra lines after the end of the paragraphs. In the Find/Replace boxes, type ^p^p in the 'Find what' box, and ^p in the 'Replace with' box. The '^p' is Word's key combination for paragraph mark, which is placed when you hit Return. We're looking for two paragraphs in a row: for when

Return was hit after a sentence and then again to create a blank line. If you only searched for a single paragraph mark, Word would find them after every valid paragraph. With your find criteria set, click Replace All. You might need to repeat the process depending on how many blank lines your father has put between paragraphs.

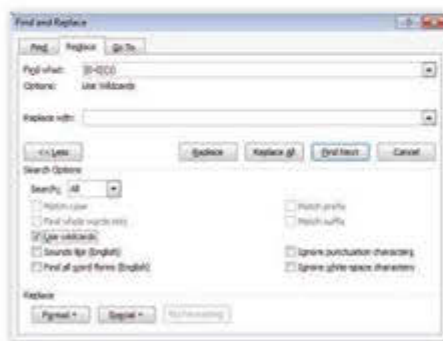
Now on to the formatting of paragraph numbers to make them more visible. In the Find section of the Find and Replace dialog, enter the following:

[0-9]{1,}

This rather cryptic entry is made up of two parts. Taking the [0-9] first: you can use square brackets round specific characters or ranges of characters to identify any character in that sequence, so [a-z] would find any lower case character between a and z inclusive; [0-9] finds all digits.

The next part, {1,} is used to say how many occurrences of the digits you want to find. There are three options; {1} would look for occurrences with exactly one digit; {1,} finds at least one digit; and {1,3} would find between 1 and 3. You can use the curly bracket part with anything you're looking for, not just digits.

In your case, don't type anything in the 'Replace with' box, but put your cursor in there, then click Format, Font. Set the font colour to Red, make sure there's a tick mark in the box 'Use Wildcards', then click Replace all. This will replace any number throughout the document, not just the paragraph numbers.



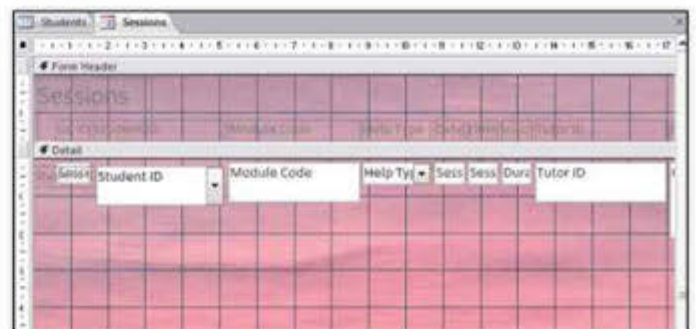
↑ Use Find/Replace with wildcards to alter formatting in Word

Control transparency effect in Access

Q I'm creating an Access database and would like to add a semi-transparent background image to my forms, in a similar way to what I can do in PowerPoint. I'd like to be able to control the transparency level so the image is very much in the background rather than overwhelming the controls on the form.

Jay Macarthur

A You can add a background image, but you can't set the transparency level from within Access. You need to create an image in a different piece of software, possibly in PowerPoint if you're comfortable working in that. Make sure you set the transparency level to the level you want, save it, then use the Picture property on your Access form and set it to use the transparent image.



↑ Set the transparency level in a different package then use the edited image

Number slides in PowerPoint

Q I'm using PowerPoint for a deck of slides, and I want to put 'Slide X of Y' at the bottom of each slide in a similar way to how I do it in Word. Unfortunately, I can't work out how to do this. I'm using PowerPoint 2007.

Kath Sanderson

A The bad news is that there isn't an automatic way to do this. You have two choices. You can either buy (or download a free) PowerPoint add-in to do the job for you. We don't recommend this, but there are products out there if you search for them.

The second choice is what we would do; it's a bit clunky but has the advantage of simplicity. You can add the current page number, and you can add static text, so when you've finished your presentation, make sure you're viewing the slide master by choosing View, Slide Master.

Click on the area at the bottom right-hand corner of the Slide Master, the Number area, then click on the <#> that you'll see there. Now click to the right of the <#>, and type something along the lines of "of 23" (assuming you have 23 slides in your deck). The number area should then look like this:

<#> of 23



➔ Set the footer on the Master Slide to get page numbers in PowerPoint

Now go back to the View menu, and choose Normal. Finally, in the Insert menu, click on Slide Number. If you don't want the slide number to appear on the first page, put a tick mark next to the option 'Don't show on the title slide'. This will work fine, so long as you remember to change the total number if you change the number of slides.

Highlight wrong values in Excel

Q I'm using Excel to manage some calculated data. The data is formatted to appear rounded to two decimal places, but behind the scenes the calculations can mean that some values are 'wrong' to several decimal places beyond that. What I'd like is some way of using conditional formatting to show when the values in the cells have more decimal places (which they shouldn't really have).

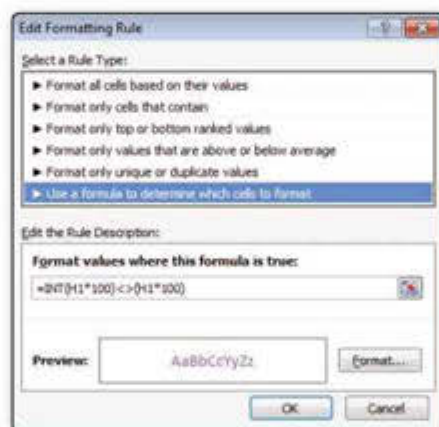
For example, a correct value such as 25.32 would be fine, but a value such as 25.3178 would be highlighted to show something odd has happened with the calculation.

Phil Chapman

A You can do this using conditional formatting using a formula along the lines of `=INT(H1*100)<>(H1*100)`. This assumes your values are stored in column H. The formula is fairly simple. It compares the value of H1*100 with the integer part of H1*100. If your value has just two decimal places, the two will be the same; if there are hidden decimal places, they'll be different.

The main confusion in the formula is why you're apparently only checking the data in cell H1. If you give Excel a formula to use in a conditional format on a range of cells, it substitutes each cell reference within the range into the formula, so as long as you tell Excel to apply the formula to the full range of cells containing the values, you should get the result you want.

It might seem as though the MOD function (which gives you the 'remainder' part of a division) sounds as though it ought to be more appropriate, but Excel's MOD function



➔ Use conditional formatting with a formula to highlight cells with hidden data in Excel

should be approached with extreme caution as it doesn't necessarily give you the results you expect, partially because of the way Excel stores its numbers internally. Anywhere you're considering using MOD, our advice is to use the technique shown here of multiplying by 100 and using INT and normal division instead.

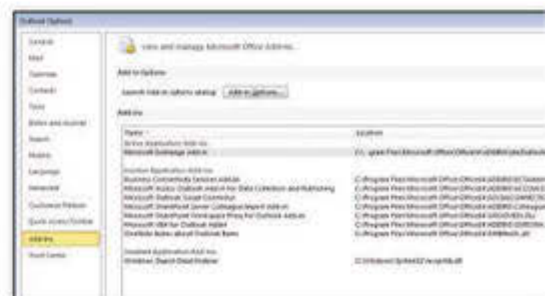
To use the formula, select the full range of cells you want to format conditionally, then choose Conditional formatting on the Home tab of the Excel ribbon. In the dialog that appears, click on New Rule. From the options at the top, select 'Use a formula to determine which cells to format', then enter the formula from the box labelled 'Format cells where this value is true'. Finally, specify a format to highlight the problem cells – changing the font colour is the most obvious option. Apply the formatting, and any cells that have hidden decimal places should show up.

Pasting text into Outlook

Q I've noticed an odd problem in Outlook 2010. If I copy something to the clipboard, go to Outlook, start a new email and attempt to paste the text into the email, it isn't there. I know I'm copying, as I can go to some other application, such as Notepad, and paste it, and the text appears. However, if I go to Outlook it disappears, and if I then go back to Notepad and try pasting, it's no longer there. If I go to Outlook and create the new email as the first thing I do, then copy and paste from Word or from IE, the text appears without any problems.

Will Shah

A There seems to be an issue with an add-in that causes this problem. From the Outlook File menu, go to Options, Add-ins. At the bottom of this dialog, you'll see a button labelled COM Add-ins. Have a look there and see if there's one called Send to Bluetooth. If there is, try disabling it, and see whether the Paste now works. If it does, the Bluetooth add-in is the culprit.



➔ Check what add-ins are enabled in Outlook from the Options dialog

Helpfile

Whatever your general PC, hardware and software woes, **Simon Handby** is here to help. Send your problems to help@computershopper.co.uk



I really don't want Windows 8.1

Q In 2013 I upgraded my old computer from Windows XP to Windows 8, and was surprised by how well it ran, especially after I loaded Classic Shell. The problems started when I kept getting reminders to upgrade to Windows 8.1, which I kept closing until you published a method of stopping them by editing the Registry.

This worked fine until November, when a screen appeared telling me I had a couple of minutes to save my work before a forced upgrade to Windows 8.1 would start. I couldn't find any way out of this and, to my dismay, the upgrade proceeded. The PC still works, but is slower than before, particularly when loading websites using Firefox.

In *Shopper 324* you advised Brian McKay that he could solve a separate problem by refreshing his PC, which I understand would reload Windows 8 in my case. This would suit me, but would I be able to leave it at 8, or will I be forced to upgrade to 8.1 again?

Peter Meakins, petermeakins58@gmail.com

A We haven't noticed any performance drop between Windows 8 and 8.1. We'd stick with the latter for security, and because it's quite tedious to get a computer back to how you want it after a system refresh. If you're certain that you want to revert to Windows 8, however, ensure that you back everything up first.

Refresh the PC by booting Windows, opening the Start Screen, clicking the power icon and holding down the left Shift key while you select Restart. You should see three tiles: select Troubleshoot, then Refresh your PC and wait while the system reboots. Now follow the refresh process, inserting your Windows installation or recovery media when prompted.

After the refresh, open the Start screen, search for 'control' (without quotes) and select Control Panel in the results. Select System and Security, Windows Update, then click Change Settings in the left-hand pane. Under Important Updates, ensure the computer is set to check for updates but lets you choose when to download and install them, then click the back button and click Check for updates.

While the computer is finding updates, open the Start screen again, search for 'regedit' and select Regedit in the results. Once the Registry Editor starts, navigate in the pane on the left to HKey_Local_Machine/System/Setup/UpgradeNotification. Here you should see the entry UpgradeAvailable with the value 1. Double-click this in the right-hand



↑ Refreshing is a great get-out-of-jail card for Windows 8, but you'll lose your personal settings

pane, change the 1 to a zero, click OK then close the Registry Editor. If you don't see the entry, you may need to repeat this step if upgrade nags start appearing later.

Windows Update will then display important and optional updates for your PC. Ideally you should install all important updates, but if you really don't want to be upgraded to Windows 8.1, you'll need to refuse updates KB2871389 and KB3008273. Find these in the list, untick them, then right-click them

and select Hide update so that they aren't presented again. Now click Install to install all of the other important Windows updates.

You should now be back to Windows 8, and you'll neither be prompted nor forced to upgrade to Windows 8.1. Note, however, that you now have to approve Windows Updates manually or they won't be installed on your PC, even if they're critically important. Although you'll see a reminder on the login screen when updates are available, you should ensure that you run Windows Update regularly – certainly at least every second Wednesday of the month, when Microsoft's monthly patches become available in the UK.

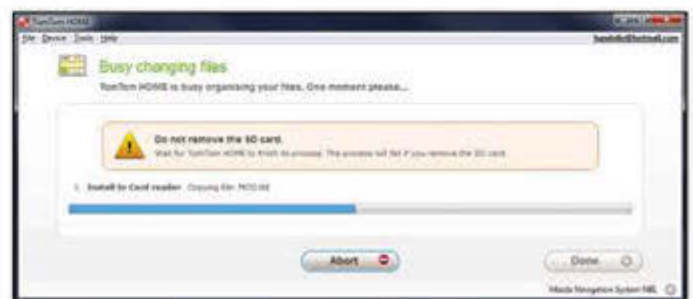
GPS won't fit on card

Q I recently bought a Mazda with a GPS provided by TomTom. It came with European maps stored on an SD card, but when I tried to update to the latest map, the TomTom HOME app told me it was too big for the supplied 4GB card. I had to download a smaller map, covering only part of Europe, which I'm not happy about. Is it possible to use a bigger card than the one supplied?

Liam Robb

A Although TomTom says the current Mazda Navigation System supports SD and SDHC cards, it only recommends sizes up to 4GB, which seems odd if the European map is bigger than this. SD cards are cheap, though, and there's nothing to stop you trying an 8GB card; buy one with a Class 10 speed rating to maximise performance.

With the ignition off, remove the current card from the car, insert the new card and close the card slot door. Turn on the ignition, switch



↑ TomTom HOME should recognise an SD card if you insert it in the car first

to Nav mode, wait for the message 'No maps found', then wait a few seconds longer before turning off the ignition. Wait for a few seconds more before removing the card and inserting it in your computer's SD card slot. TomTom HOME should now recognise it as a navigation device, after which you can install the latest software. If it doesn't work, you can revert to the original Mazda SD card at any time.

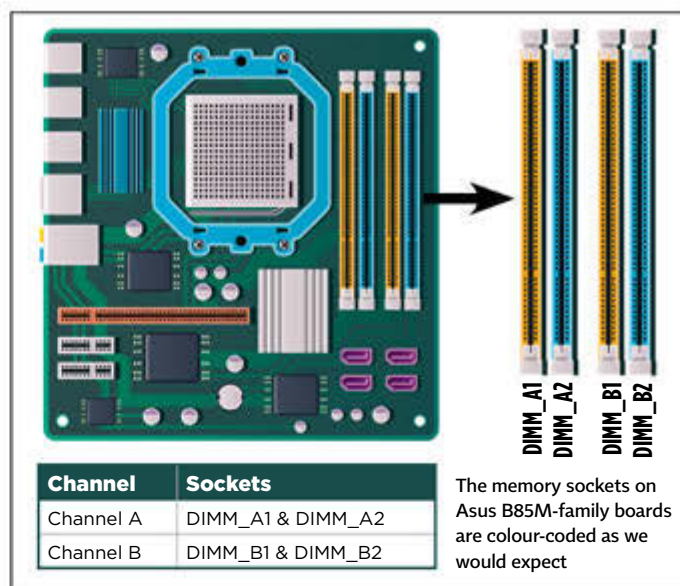
Where do I slot in?

Q I have a Asus B85M-E motherboard and two memory modules. Could you tell me which DIMM sockets I should use for dual-channel memory operation? When I built the system I used slots A1 and B1, which are black, but in issue 327 you reviewed the Asus B85M-G, which is similar to mine. Your reviewer said DIMMs should be fitted in consecutive slots for dual-channel operation.

Tom Lugwid, tomlugwid@yahoo.co.uk

A We haven't reviewed the Asus B85M-E, but its slots are colour-coded as we would expect: black for A1 and B1, and yellow for A2 and B2. Your current configuration ought to give you dual-channel operation, but you can verify this using the free CPU-Z utility from www.cpuid.com. Once installed, run the software, click on the Memory tab, and verify that it indicates Dual in the Channel # box at the top right. If it does, the system is set up correctly.

The B85M-G board is very similar, and ought to be the same. Unfortunately our review sample has since been returned to Asus, so we weren't able to further investigate why it behaved differently.

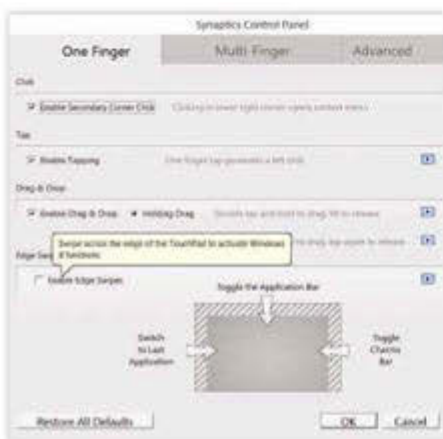


Gesturing at Windows 8.1

Q I was given a Lenovo Yoga 2 laptop running Windows 8.1 last year. It's nice, but I don't like the way various menus appear when I accidentally brush my hand across the trackpad. Can I turn this off?

Ruth Clarke

A The trackpad is responding to edge swipe gestures, a Windows 8 feature, but you can disable them. Open the Start screen and type 'Control' (without the quotes), then select Control Panel in the results. If you're using the list view, click Mouse, otherwise select Hardware and Sound then select Mouse under the Devices and Printers heading. In the mouse applet, select the Device Settings tab and click the Settings button to open the Synaptics Control Panel. Untick Enable Edge Swipes, then click OK to save the change and dismiss the window.



↑ Not everyone gets on with edge swipes; disable them in your mouse or trackpad software

Virtualising reality

Q Many years ago I installed and maintained IBM's virtualisation operating systems VM/370 and VM/SP. With those, I could define a virtual machine such that an existing physical computer running IBM's MVS operating system, or even VM itself, could be booted and run as a virtual machine. Can any of the various virtualisation offerings available for the PC let me do something similar, by running my old Windows XP system as a virtual machine within a later version of Windows, or even Linux?

Steve Webb, steve@webbsfamily.co.uk

A This is certainly possible with free software from VMware. You'll need to sign up for a free account and download the VMware vCenter Converter Standalone from www.vmware.com/go/getconverter. You'll also need to download a version of VMware Player for either Windows or Linux from <http://tinyurl.com/330vmware> so you can use the virtual machine (VM).

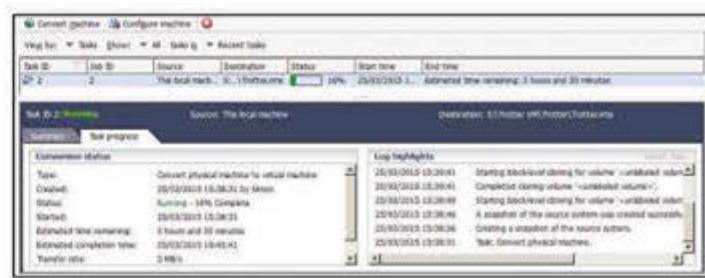
Install the vCenter Converter Standalone on the XP system and select Local installation when prompted, then run the program. Click the Convert machine button, and on the next screen select Powered-on machine and This local machine. Click Next, then change the destination type to 'VMWare Workstation or

other VMWare virtual machine' and change the VMWare product to VMWare Player 6.0.x. Select a location for the VM; this needs to have enough space to store the full contents of your Windows XP machine, so a removable or network storage drive would be ideal. Click Next, then Next again on the Options screen and finally click Finish to create the new VM. This will take some time.

While the VM is being created, install VMWare Player on your target Windows or Linux system: simply run the installer and provide an email address when prompted. When the VM has been created, copy the virtual machine directory and its files to a folder on the host system, then run VMWare Player, click Open a Virtual Machine, navigate to the folders containing the VM, select the .vmx file and click Open. You can tweak the VM's memory or other hardware settings, or just start the machine with the play icon.

The virtual machine should be as close as possible to your old XP computer, but if you plan to use the VM from now on don't forget you need to back it up as you would do a physical PC. It's best to do this by backing up the host PC including all the VM's files. Unfortunately, VMWare Player won't create snapshots of the VM, which let you save an image of the virtual machine – you'll need to buy VMWare Workstation for that. ☹

→ VMWare offers this free tool to create a virtual machine from a physical one



Make Dropbox even better

Dropbox may be great at keeping all your files up to date, but add-ons make it capable of so much more, as **Clive Webster** explains



WITH SO MANY people using Dropbox, it's no wonder that developers have created their own applications to use the service in different ways and to extend its capabilities. This month we've rounded up the best Dropbox apps and services, so that you can get more from your account.

SHARE WITH NON-DROPBOX USERS

Dropbox can be quite a personal, restricted service: you can set up a shared folder for a group of people, but what if you don't want to force friends, family or clients to sign up to Dropbox to work with you? Well, a couple of services allow people to save files to your Dropbox folder without having to use Dropbox.

DroptToMe is one of the best. Register for this free service at dropitto.me and you can set up a unique, password-protected web address to which clients and colleagues can upload large files. Streamlining large files away from your email account will make your email software more responsive, make email backups smaller, and mean that important large files are already stored neatly in a Dropbox folder rather than buried in an email.

To sign up to DroptToMe, click the Register button. If you're already signed into Dropbox (via www.dropbox.com) you can click the Register button on the next page too. On pressing the second Register button, a Dropbox authentication page will load, asking you to Cancel or Allow DroptToMe access to

your Dropbox files and folders; click Allow. You'll then need to enter a username, email address, password and Upload password; read the prompts for each entry if you're unsure about what to enter, as they're very helpful. Click Register and, presuming your username hasn't been taken, DroptToMe will provide your unique upload address (www.dropitto.me/UserName).

When you next request a file from someone, provide this upload address and the Upload password; when the recipient clicks the link they'll be taken to a DroptToMe web page, asked for the Upload password and shown a basic 'Choose file' button with which to find the relevant file. There is a 75MB file limit, and only one file can be sent at a time, so you should remind the sender to use an archive tool, such as WinZip or WinRAR, to bundle multiple files together. Uploaded files appear in the automatically created DroptToMe folder in your Dropbox account.

DroptToMe's beta status might worry you if you're dealing with sensitive or important files. SupplyDrops (supplydrops.com) is one

answer for very sensitive data, as it sets up an upload location (called a Drop Zone) that's protected by 128-bit SSL encryption.

However, although the upload link to this location is password-protected, it's only valid for up to 48 hours. If you need a

permanent, secure or more professional upload system, you might be interested in Airdropper

(airdropper.com). For \$9 a month (around

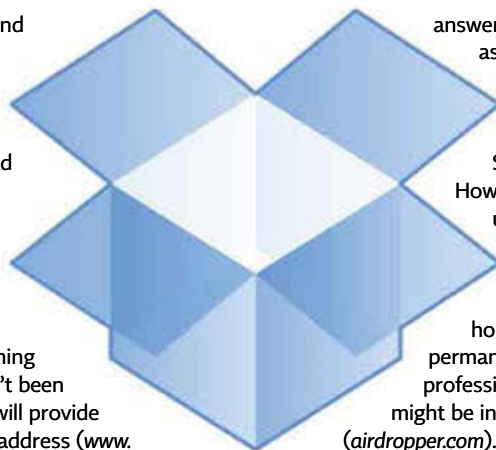
£6) you can design your own upload page (with your corporate branding, for example) and provide the ability for users to download files via that page. SSL encryption, large file sizes and 10GB of extra storage are included.

While FTP-like upload engines such as DroptToMe might be useful, Send to Dropbox could be even more so. This free service creates an email address, and all emails sent to that address have their attachments automatically stripped and uploaded to your Dropbox account. Visit sendtodropbox.com and click the big Sign Up button. The Dropbox authorisation page will appear; click Allow and, after a little processing time, a unique email address will be generated. Click the settings button under this address and you can set rules as to where emailed files appear in your Dropbox account: you can organise by the Subject field of an email, for example, to separate groups of essays, or by the From address to separate clients' files. There's a whitelist, so you can block all but verified email addresses and, under the Options tab, you can select whether to save email text. You can even change the automatically generated email address if you like.

AUTOMATIC FILE SORTING

Unfortunately, there's no single add-on that does file organisation satisfactorily on its own, so we'll combine two. First, visit www.sortmybox.com and click the Login with Dropbox button. The Dropbox authentication page will appear (for 'Sortbox'), so click Allow. You'll be presented with SortMyBox's web app, where you can set 'Sorting Rules'. These are simple logical rules, such as the default

(Continued page 138)



⬆ Avoid huge email attachments and lost files by using DroptToMe to allow anyone to upload files directly to your Dropbox account

Simple Dropbox add-ons

There are loads of small add-ons, widgets and browser extensions to make Dropbox quicker to use, more convenient, more fun and even more powerful. Here are some of our favourites

DROPBOX PLUGIN FOR WINDOWS

sourceforge.net/projects/dropboxcopyplug

Adds options to move or copy files to the Public folder, ready for sharing. Even better, it automatically copies the Public link to your clipboard, so you just need to press Ctrl-V to paste the link into your email. To find your Dropbox User ID, paste a Public link into a text editor; it's the string of numbers after the /u/ part of the URL.



DROPBOX DROPLET

www.apple.com/downloads/dashboard/email_messaging/dropboxdropletwidget.html



Drag and drop files on to this Apple Dashboard widget and they'll be uploaded to the Public folder of your Dropbox account. Droplet also automatically copies the Public URL of this file to your clipboard, so you only have to press Command-V on your Mac to paste the link into your message. You must provide Droplet with your Dropbox ID before using it.

DROPBOX FOLDER SYNC

satyadeepk.in/dropbox-folder-sync



Automatically synchronises any folder on your PC with Dropbox, making Dropbox a useful backup service. Alternatively, you don't have to worry about uploading files to Dropbox when you're switching between multiple machines; this could be useful for everything from documents to saved games. The sync command appears in the right-click menu.

Dropbox Folder Sync automatically synchronises any folder on your PC with Dropbox, making it a useful backup service

MACDROPANY

www.zibity.com/macdropany.html



MacDropAny synchronises any folder on your Mac with Dropbox, allowing you to use Dropbox as an ad hoc backup location or automatically keep crucial files up to date no matter which Mac you're using. Unlike Dropbox Folder Sync, this add-on connects to many online storage services, including iCloud Drive, Box and Google Drive.

BOXCRYPTOR

www.boxcryptor.com



Applies AES-256 and RSA encryption to protect sensitive or important documents from hackers and nosy colleagues. The free service can only connect with one service (other online storage providers are supported, as well as Dropbox) and only on two devices; €36 a year (around £26) allows you to connect to multiple providers from all your devices. There are two pricing plans for businesses, starting from €72 a year (around £52).

PANCAKE

pancake.io



Host a blog or simple website from your Dropbox account, rather than faff around with FTP servers. Write your text in any application you want, using either super-easy Markdown or HTML code, save it to the Pancake folder on your Dropbox account, and moments later it will appear on the internet as a blog post. PDFs and Office documents can be shared via the Pancake folder, and you can use your own custom URL (via iwantmyname.com) and use or edit many themes.

WORDPRESS BACKUP TO DROPBOX

wordpress.org/plugins/wordpress-backup-to-dropbox



Avoid blog Armageddon by backing up all your posts, pictures and other WordPress media to Dropbox. Download the Zip file, and unzip its contents to the /wp-content/plugins/ directory of your blog, or else use the plugin tool. From the plugins settings page there will be a new Backup menu from where you can configure your blog's Backup routine. Dropbox will require you to authenticate the plugin the first time you use it.

DROPBOXIFIER

dropboxifier.codeplex.com

Dropboxifier moves certain files to Dropbox, replacing them with a symbolic link, fooling applications into believing the file is held locally. This is excellent for saving games – particularly if you have a game installed on multiple machines – or settings files. Point Dropboxifier to a folder on Dropbox, and then add folders and files via the browser to the left.



Send to Dropbox strips attachments from emails and uploads them directly to Dropbox

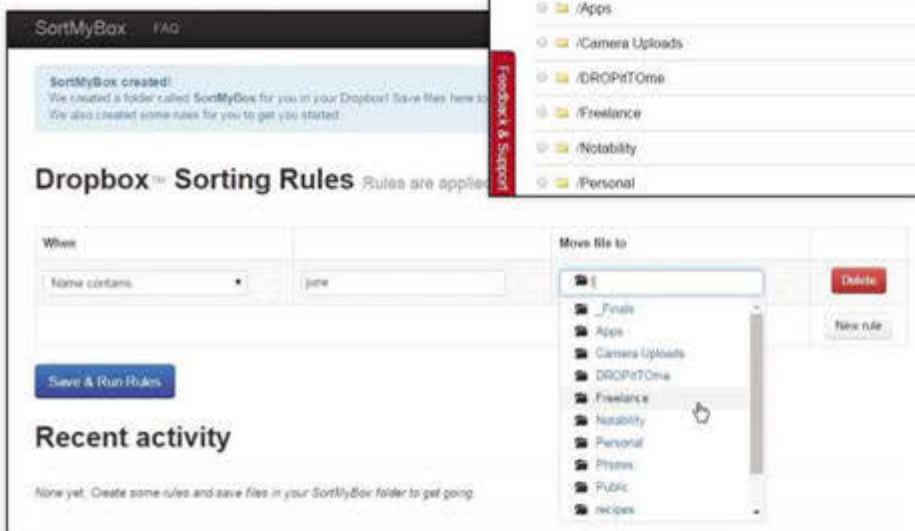
'When a file extension equals jpg, png, gif Move file to /Photos'. Delete or modify the three suggested rules to suit your needs. For example, we're going to pretend to edit a local newsletter, so we want all files with 'june' in the title to be moved to the June folder on our Dropbox account so we can put all the images and words together quickly for the June issue. The rule is, 'When Name contains june Move file to /Freelance/Newsletter/06 June'.

Unfortunately, as well as having a snigger-inducing name, SortMyBox only monitors the SortMyBox folder on your Dropbox account. Moreover, we're far too generous to our imaginary newsletter contributors, so we've offered them most of the above methods of submitting files. We therefore need an automated way of moving files from all the disparate locations on our Dropbox account to this one 'magic folder'. Enter Wappwolf's Dropbox Automator.

Head to wappwolf.com/dropboxautomator and click the Try now! button. If you click the Connect Dropbox button you will allow Automator access to your entire account, while the 'one folder access' is better if you're

able to limit clutter to a single folder; perhaps you'll only use Send to Dropbox, for example, and so only need to tidy this one folder.

Either way, Dropbox will ask you to authorise 'Wappwolf' for your account, so click Allow. You'll then be presented with the folder structure of your Dropbox account. To move files received from the collaboration tools discussed above automatically, select their folders; for example, Send to Dropbox saves those stripped attachments in the /Apps/Attachments folder, so click /Apps and then select the circle next to the /Apps/Attachments folder, then click Next. Scroll down to select 'Save in Dropbox' and type /SortMyBox before clicking the Add Action



SortMyBox and Dropbox Automator let you automatically sort and organise your Dropbox account

A free Microsoft Office plug-in prevents one Dropbox collaborator from opening an Office document already opened by another collaborator

button. Unless you want to copy, rather than move, the file (and quickly eat up your Dropbox space), scroll down to the bottom of the list and select 'Delete the original file' and then Add Action. There's a reminder that you can retrieve deleted files from the Dropbox web app anyway, so there's little to be worried about. Unless you want to add other actions, click the 'finished?' button at the top of the page. Repeat this process for each upload location. Now you have a system where people can send you files however they like, and yet all these files are automatically sorted and collated neatly for you.

DROPBOX FOR WORK

There are a few add-ons that might be worth looking at if you're using Dropbox at work. The free Microsoft Office plug-in Conflicted Copy Pro (see www.conflictedcopypro.com) prevents one Dropbox collaborator from opening an Office document already opened by another collaborator, ensuring Dropbox

doesn't spawn multiple conflicting copies of the same document.

DropboxPortableAHK might be useful if you often visit locations where installing Dropbox, or logging on to the site, is prohibited. Visit nionsoftware.com/dbpahk to download the free software that turns a USB flash drive into a portable, self-reliant Dropbox receptacle – just plug your flash drive in, and all your Dropbox files are there ready to be used and synchronised. The site has detailed instructions on how to set up a flash drive for DropboxPortableAHK.

Finally, for Dropbox addicts running Apple OS X that use the service at home as well as for work,

Dropbox Encore might be invaluable. Head to www.joyofmacs.com/software/dropboxencore to find out how to separate your work files from your personal ones.

NEXT MONTH

ENHANCE YOUR ROUTER

We show you how to unlock the full potential of your router with the replacement DD-WRT firmware

Using and abusing convolution effects

Convolution effects let you apply the acoustics of real spaces to recordings, but that's only the half of it. **Ben Pitt** goes in search of strange new worlds



REVERB IS ONE of the most important audio effects in music and video production. It gives sounds a sense that they exist in a physical space rather than in a vacuum. It achieves this by simulating an acoustic phenomenon that's present every time you hear a noise.

Sound waves bounce off surfaces in a similar way to light. Sound travels much slower than light, though, so these reflected sound waves take a bit of time to die down. It's this pattern of reflections that give spaces their distinctive sonic signature. The best concert venues and recording studios are carefully designed to produce a reverberation that flatters music, but every stadium, stairwell, church and car interior has its own unique reverberation.

There are various ways to use reverb in your productions. One is to record in an environment that has the reverb you want. This is standard practice for classical recording, and it's often used when recording drum kits, too. The larger the instrument or ensemble, the harder it is to record it without capturing the reverb in the room, so you need to record in an environment that has the reverb you want to hear.



In most other cases, recordings are captured with as little natural reverb as possible. That's achieved by placing the microphone close to the source, and perhaps by using acoustic screens that absorb reflections. With a recording that's relatively free of natural reverberation, there's scope to apply reverb digitally in recording software.

Some reverb effects use an algorithm that produces a complex array of discrete echoes. This closely mimics what sound waves do in real spaces. Different environments can be simulated by adjusting the density of echoes, how often they repeat, how long they last for and the balance of frequencies. These algorithmic reverb effects can sound rich and atmospheric, but they rarely sound as realistic as convolution reverb.

Convolution involves taking a specially created recording of a real space – a bit like an acoustic fingerprint – and using it as the basis of the reverb simulation. If you want the sound of a cathedral, nightclub or aircraft hangar, rather than rely on a complex algorithm to synthesise the effect, all you need is a special recording of that space. It's extremely useful for music production, and it's widely used in TV and film production, too – making sure that sound effects and overdubbed dialogue matches the acoustics of the environment you see on the screen.

Convolution reverb involves a huge amount of number crunching, so while it's conceptually pretty simple, it's only in recent years that desktop computers have been powerful enough to make it widely accessible.

CONVOLUTION IN ACTION

The easiest way to understand how convolution works is by looking at how it's used. To capture the acoustic fingerprint of a real space, you need to start with an impulse. This is an instantaneous burst of acoustic energy that creates the reflections you want to capture. Professional audio engineers might typically use a starting pistol.

The sound of the pistol – and more importantly, the reflections of that sound as they bounce around the space – are captured with a microphone or, more usually, a pair of microphones pointing left and right, as this gives a stereo reverb effect. This recording is known as an impulse response, or IR.

The IR is fed into a convolution reverb effect and applied to recordings. This involves multiplying the recorded signal with the IR. A calculation is done for each and every sample, and the IR plays out for its duration at each iteration. So for 44.1kHz audio, the IR starts playing 44,100 times a second, and the volume of each iteration depends on the current sample value of the audio being



↑ The RecForge II app lets you record in WAV format and check the results for clipped waveforms

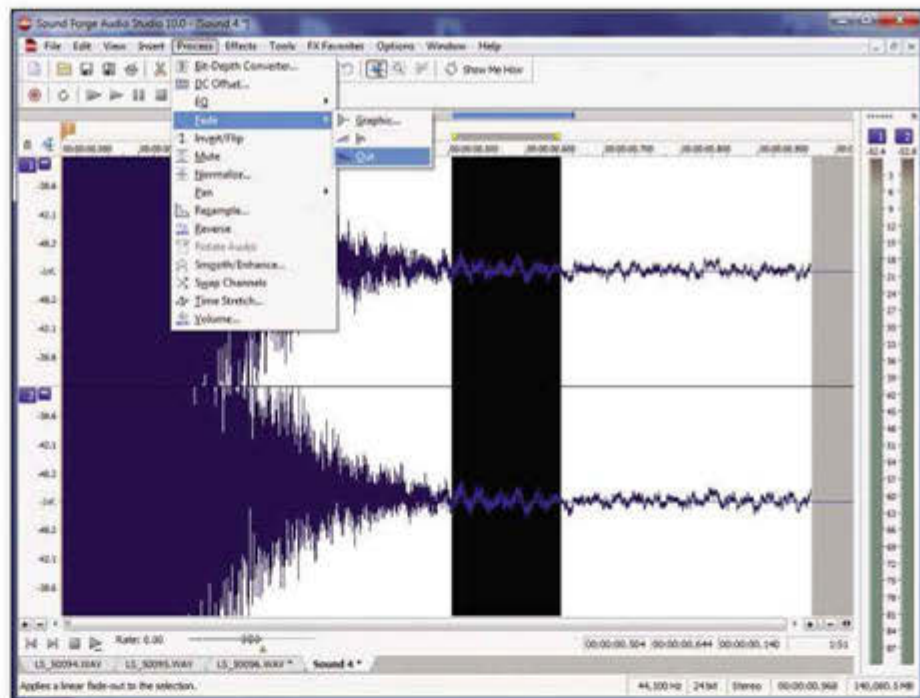
processed. All that remains is to add all these iterations together. For a two-second IR at 44.1kHz, that means 88,200 IRs playing at the same time, all at different levels depending on the waveform position when it started playing.

That's what's going on inside the plug-in. What you hear is an authentic simulation of the reverb from the space where the IR was recorded. Whereas algorithmic reverb tends to sound lush and enveloping, convolution reverb often doesn't sound like reverb at all. It's more that the dry signal takes on the acoustics of the space that you're simulating.

This technique isn't limited to re-creating the sound of real spaces. It's often used to simulate analogue effects such as plate and spring reverbs. These devices are literally metal plates and springs with a mini speaker at one end and a microphone at the other. Before digital audio, they were the only way that reverb could be simulated. They don't sound too realistic but they have a distinctive quality that can be subjectively pleasing.

Convolution isn't limited to reverb, either. It can be used to create delay effects using discrete echoes, or to capture the frequency response of a guitar amp's speaker. In fact, you can use just about any short recording as an IR, as we'll see below.

Convolution plug-ins come with a library of IRs. For the most expensive plug-ins such as Audio Ease Altiverb (€600, around £433, from www.audioease.com), it's as much the IR library as the plug-in technology that justifies the high cost. Altiverb's library includes world-renowned concert halls, opera houses, churches, cathedrals, recording studios and film-scoring stages, plus curiosities such as Alcatraz prison, a cave, a forest and a Boeing 747. It also includes IRs from classic studio hardware such as the Roland Space Echo, various EMT plate reverbs and the Lexicon L480.



▲ Sony Sound Forge Audio Studio is perfect for tidying up your impulse response recordings

There are cheaper plug-ins such as Voxengo Pristine Space (\$120), Waves IR1 (\$250) and Waves IR-L (\$150). Convolution effects are included with various high-end recording programs such as Steinberg Cubase Pro and Ableton Live. If you don't want to splash out, check out the free VST plug-in called SIR1 (www.siraudiotools.com/sir1.php), which comes with a small collection of IRs. There has been a library of free IRs for many years at noisevault.com, although at the time of writing the site was closed for maintenance.

START WITH A BANG

Expertly crafted IRs captured in world-class venues are all well and good, but it's much more fun to create your own. It might not be the most luxurious reverb you'll ever

hear, but it's perfect if you're looking for something a bit different.

You'll need an interesting space to capture, but it's probably best to start with your home while you're honing your technique. There may not seem to be much reverb at all, but it will always exist wherever there are surfaces for sound to bounce off.

The second thing you need is an impulse. This is a specific kind of sound that, when recorded digitally, would look like a spike in the waveform lasting just one sample. Because of its instantaneous nature, it contains all frequencies.

A starting pistol works well because it has a full-bodied tone, and also because it's loud. In any environment there will be a certain amount of background noise – from traffic, computers, central heating, hiss from the recording equipment and so on. The louder the impulse, the more you're able to turn down your recording equipment and reduce the relative level of the background noise.

If you don't have a starting pistol lying around, there are lots of other options. Popping a balloon works well, and even a hand-clap does the job. It won't produce the full spectrum of high to low frequencies, but that's not necessarily a problem – a reverb that's mostly middle frequencies often sits better in the mix anyway. Even a finger click or foot stamp can work well if you want to accentuate certain frequencies over others.

Recording the IR is the trickiest part if you're on a budget. Dedicated handheld recorders from Tascam, Zoom or Olympus are ideal, as they include high-quality stereo mics and record lossless WAV files to SD cards. Prices start at about £70 for Tascam's DR-05.

If you have a laptop-based music production setup complete with microphones, you may be able to transport it around the house as necessary. Otherwise, you'll have to make do with a smartphone or tablet. These



▲ SIR1 is a free convolution VST plug-in that comes with a small collection of IRs

devices' built-in microphones tend to be pretty basic but we've found they're good enough to get usable results. The biggest drawback is that their microphones are mono, so you don't get the sense of space that you would from a stereo recording.

You'll need an app to capture the recording and save it as a WAV file. Avoid compressed formats such as MP3 as you'll lose the finer details of the IR. For iOS, WavePad Audio Editor Free (tinyurl.com/330wavepad) by NCH Software does the job, but be warned that the free version doesn't allow edited recordings to be exported – once you edit them, the export options are greyed out. However, it can export the raw recordings in WAV format as an email attachment. Before you record, tap the cog and select WAV/PCM, 44.1kHz, 24-bit to ensure the best possible quality.

There are masses of audio recorder apps for Android. We tried RecForge II – Audio Recorder (tinyurl.com/recforge), which did the job well. There's an option to turn Automatic Gain Control off and set the volume manually. This stops the phone automatically adjusting the volume while recording, which can lead to

different positions, both for the microphone and the impulse. Locating them at opposite ends of the room will allow you to capture less of the direct sound, thereby increasing the relative volume of the reflections for a better dynamic range. You could also try creating the impulse in a different room to the microphone. Anything goes, and it's often the more experimental techniques that produce the most interesting results.

ACT ON IMPULSE

Once you've got some raw material to work with, it's time to send it to your computer and knock it into shape. You'll need a stereo editor to this. Audacity (web.audacityteam.org) is a freeware application that does the job, but we prefer Sony Sound Forge Audio Studio (www.sonycreativesoftware.com). It's available as a 30-day free trial, and while it costs to buy £40 from the official website, it's currently available from Amazon for £21.



↑ Altiverb comes with impulse responses from some of the world's best concert venues

If you don't have a starting pistol lying around, there are lots of other options. Popping a balloon works well

an unrealistic IR and increased noise. On a Nexus 4 phone, it produced a surprisingly clear recording with a low noise floor.

Whatever you use to record, it's worth getting plenty of takes at different volumes. The aim is to capture an IR that's just shy of full volume, as this will give the cleanest recording with the greatest signal-to-noise ratio. It's also worth trying out a range of

Editing IR recordings is relatively simple. Choose a take that sounds like a good candidate and copy and paste it to a new file. Zoom into the waveform and trim the start as closely as possible. Trimming the end isn't so easy as the waveform probably doesn't have enough resolution to show what you can hear. However, Sound Forge Audio Studio has a vertical zoom function that lets you see the

waveform magnitude in more detail. As you zoom in you should eventually see the noise floor where the triangular part of the IR turns into a steady volume. You don't want this noise floor, but cutting the recording dead will sound abrupt. A better option is to fade out so the triangular shape of the IR goes all the way to silence. You can then discard the noise beyond the end of the fade.

Save this as a WAV file, giving it a descriptive name, and you're ready to bring it into a convolution reverb plug-in.

If you don't already have a plug-in installed, we recommend starting with SIR1, which is free from www.siradiotools.com/sir1.php. It's a VST plug-in so you'll need to use music-production or video-editing software that supports this format. You'll also need to make sure the host software knows where to find the plug-in. VST plug-ins are just .dll files that sit in a folder, but software publishers



As well as concert halls and opera houses, Altiverb's library includes unusual settings such as Alcatraz prison and a jumbo jet



We've used multiple instances of the SIR1 plug-in here (running in Steinberg Cubase Element), and used automation envelopes to layer and alternate between them

have different ideas about where this folder should be. We use C:\Program Files\Vstplugins but it doesn't matter as long as you remember where it's installed and point the host software to it in its Preferences.

Reverb plug-ins are normally used on auxiliary channels. That way you can adjust an aux send control on other channels to feed the reverb plug-in from a combination of sources. For example, you might want a bit of reverb on the lead vocal, more on the backing vocals, lots on the strings and so on. This approach means the clean signals will appear in the mix too, which is normally what you'd want when adding reverb.

One of our favourite IRs we created while preparing for this article was made by thumping the inside of a wardrobe

However, when using convolution for special effects, it's often necessary to hear only the effect's output and none of the clean signal. To do this, you'll need to apply the effect as an insert on the channel for that particular instrument. You'll still have the option to include the clean signal using the effect's controls. In the long run you may want to use an auxiliary channel, but for now let's add the plug-in as an insert. Most video-editing software doesn't offer auxiliary channels, so it will have to be an insert.


Convolution plug-ins are fundamentally pretty simple: load up an IR file and you're in business. There will be controls to set the levels of the dry (clean) and wet (processed) signals. Most convolution plug-ins, including

SIR1, also include options to manipulate the IR shape. A Reverse button plays the IR backwards, which can sound pretty dramatic. The Predelay control adds a delay before the effect is heard. In SIR1, the Length control cuts off the end of the IR, while the Envelope control fades it out rather than stopping it abruptly. Adjusting the Attack controls can make it start softly, too.

The Stretch control adjusts the length of the IR. In some plug-ins this is done using time-stretch algorithms, but here it's achieved simply by adjusting the playback speed of the IR. This also changes the IR's pitch but it avoids any time-stretch artefacts. Stereo In and Stereo

notes will really ring out while others will have little effect. That can sound a little clumsy if you're processing a pitched performance such as a vocal with a pitched IR. However, use piano chord IR on a non-pitched performance such as a drum track and each drum hit will perform the chord but with a different balance of frequencies. It's a great trick for making drum tracks take on an air of otherworldliness while still keeping all the nuances of the original performance.

If you don't have acoustic instruments lying around, pots, pans, radiators, toys and anything else that makes an interesting noise when you hit it are all fair game. You could also fire up some virtual instruments in your music-production software and create some short sonic bursts, export them and turn them into discrete WAV files in a stereo editor.

Often the beauty of this technique is its unpredictability. One of our favourite IRs that we created while preparing for this article was made by thumping the inside of a wardrobe, which created an impressively authentic locked-in-a-wardrobe effect. Another was a kissing noise, which made a drum track sound like a succession of fruity kisses. A fast sine tone sweep smeared frequencies across time, turning speech into a surreal alien babble. We're sure that you'll find lots of other experimental techniques that produce interesting results. 

IR adjust the stereo width of the input signal and the IR respectively. At the bottom is a graphical EQ editor, although you may prefer to use your host software's EQ controls.

GOING OFF PISTE

Making audio sound like it was recorded in your living room or bathroom is entertaining in its own right, and it might be extremely useful if you want to improve the realism of sound effects in video productions. Any short recording can be used as an IR, though.

A short piano or guitar chord can produce intriguing results. This chord acts like a sonorous resonant chamber for whatever is fed through it. If you're using IRs with discernible pitches, you'll find that those

NEXT MONTH

DESIGN A NEWSLETTER

We fire up Xara Photo & Graphic Designer for a crash course in desktop publishing

Light painting with your smartphone and tablet

Following our tutorial on using long camera exposures to create amazing light paintings, **Ben Pitt** ups the ante with smartphone and tablet apps



TWO MONTHS AGO we covered light painting in Multimedia Expert, and enjoyed it so much that we couldn't wait to have another go. This month we're looking at how you can use your smartphone or tablet to get involved and create even fancier long-exposure effects. If you missed that issue, you can download it from www.shopperdownload.co.uk/mexpert/me328.pdf.

Smartphone cameras are steadily improving in image quality, but it's only recently that it's become possible to adjust exposure settings manually. The ability for apps to control the camera's shutter speed was introduced in Apple iOS 8.0 and Android 5.0 Lollipop. However, even if you're able to update your Android device to Lollipop, that doesn't necessarily mean your device's hardware supports these features. There are workarounds, though, as we'll discuss below.

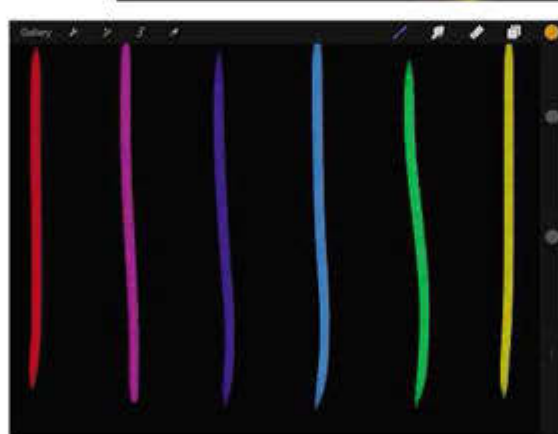
STAND AND DELIVER

Light painting requires a slow shutter speed, and unless you want everything to be blurry the camera must be mounted on a tripod. Smartphones and tablets generally don't come with tripod threads, so you may need to buy something especially for the job. There's no shortage of choice on Amazon and elsewhere, with prices ranging from £15 for the Joby GripTight GorillaPod to various no-brand mini tripods costing a couple of pounds.

Some phone models attach to a normal tripod, which gives more versatility as to where you place it, but tripods for tablets are harder to come by. There are various clamps and holders available that can be pressed into use. For your first attempt you can probably get away with propping up the smartphone or tablet between books or other household items, but to shoot outside it's best to get something more substantial.



A quick sketch using a drawing app provided the light source for this product shot, not only providing the backdrop but also illuminating the subject



You'll also need a camera app to capture your light paintings. The latest iOS and Android operating systems support manual shutter speeds, but their native camera apps don't. Even the ones that do often limit the shutter speed to half a second, which isn't long enough to create a light painting.

The apps we used take an unconventional approach to image capture. Rather than take a photo in the normal way, they essentially

use the device's video-recording mode to capture a constant feed from the imaging sensor, and then superimpose the frames on to one other to build up a long exposure. It's a fairly crude approach that limits the capture resolution and can skew colours, but there's one major advantage: these apps can show a live preview of the light painting as it's being created. The only dedicated camera we've seen that can do this is the Olympus E-PL7; with all other models you only get to see the results after the capture is complete.

For iOS, we used Slow Shutter Cam (79p, tinyurl.com/330sscsm). It claims to be compatible with iOS 7 but it behaved more reliably after we'd updated our iPad to iOS 8. Tapping the iris button reveals three modes: Motion Blur, Light Trail and Low Light. Light Trail is the one to go for. Below are two sliders, one for Light Sensitivity and another for Shutter Speed. Pushing Shutter Speed to the right puts it into Bulb mode, whereupon you can start and stop capturing whenever you want by tapping the shutter button.

The Light Sensitivity control takes a little getting used to. Think of it as a volume control for the incoming video feed. Setting it

Light painting requires a slow shutter speed, and unless you want everything to be blurry the camera must be mounted on a tripod



Hologarium for iOS can create floating 3D text and images

to Full means that colours are added to the light painting as soon as they're detected by the sensor. Reducing this control to its lowest $\frac{1}{128}$ value means that a colour has to appear for 128 frames before it's recorded at its full intensity. This means that light sources appear weaker if they move faster, just as they would in a conventional long exposure.

There's a preview of the live feed in the corner of the screen to help build up the composition. Colours are never brighter than in the incoming video feed, so static areas of the image don't become blown out. Exposure control is limited, but an AE lock button stops the exposure of the incoming video feed from varying automatically. Shine your light source directly at the camera and tap the AE Lock button, and this should prevent the scene becoming overexposed. It's also possible to set the focus by tapping the preview image and lock it using the AF lock button.

It's clever stuff, and although the results look different to a normal long exposure, it works well in its own right. The app was able to capture at resolutions up to 5 megapixels on our third-generation iPad, and the ability to preview the work in progress on the iPad screen let us create paintings that would have been impossible using a dedicated camera. We were also able to capture surreal portraits using the iPad's front-facing camera, albeit at this camera's limited VGA resolution.

On the Android platform our best successes were achieved with Long Exposure Camera 2 by AAASDream (tinyurl.com/330longec). It works on a similar principle to Slow Shutter Cam, except that there's not much scope to reduce the intensity of the recorded image. We found that reducing the

Exposure control to EV-12 helped to prevent overexposure, but there's no option to build up the intensity of colours over time. The options to colour-correct the image after capture are welcome, though. The app is free and can export at 800x600 resolution with a watermark. A £1.56 in-app purchase allows higher resolutions up to the device's screen resolution and removes the watermark.

ANIMATED LIGHT

Smartphones and tablets can be used to capture light paintings, but they can also be used to illuminate them. In fact, it's hard to imagine a more versatile light source. Two months ago we saw some interesting results by winding some electroluminescent wire around coat hangers to create a square-shaped light source. All you need to do the

same with a tablet is a drawing app. We used Procreate for iPad (£4.49, tinyurl.com/330procreate) but alternatives include Brushes 3 (tinyurl.com/330brushes), which works with all iOS devices and is free. Android users looking for a freebie should go for Artflow (tinyurl.com/330artflow; see *App Creative*, *Shopper 317* for more on drawing apps). Start with a black canvas so the rectangular screen shape isn't visible, draw a simple shape on the screen and use it to create a light painting. You may need to export the drawing as a JPEG to display it without showing any of the drawing app's interface onscreen. You'll need another iOS or Android device or a conventional camera to take the photo.

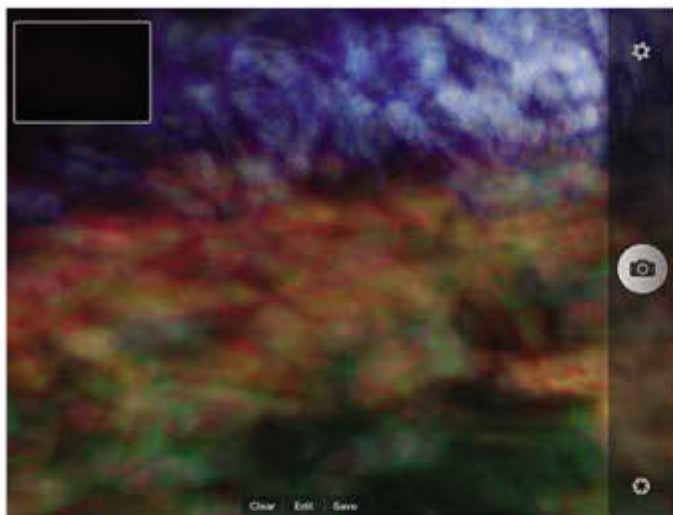
We used this method to create our photo of a camera with a rainbow of coloured lights behind it on page 143. The camera itself was

This shot was created using a custom-made animation, saved as a video file and played back on an iPad





A smartphone playing a video is the only light source in this photo, taken with a 30-second exposure



Slow Shutter Cam for iOS lets you see your light painting take shape on the device's screen. This image was painted using coloured LED lights



Dr.Light Painting generates floating text from your Android device's screen

illuminated using the same light source, held up close so that certain colours dominated on different parts of the camera and stand. This process was pretty hit and miss, especially when it came to getting a pleasing exposure level for the main subject, but unexpected results are part of the creative process.

Tablets and smartphones don't just show static images. A video is a constantly evolving light source, and playing a video on a device that's moving through a scene can create rich, complex patterns. We used this technique to illuminate piano keys with a smartphone playing a video (above). The phone's small screen meant we could aim the light precisely,

There are lots of apps that create interesting moving patterns. Games often have carefully chosen colour palettes that can act as an interesting light source. The only downside of both games and videos is that you're stuck with a rectangular frame, which can dominate the resulting light paintings.

We had lots of fun with an iOS app called Thicket (£149, tinyurl.com/330thicket), which is best described as an interactive art app. It creates a cluster of geometric patterns that evolve as the screen is touched. It's just the thing for creating delicate wisps of light.

We also used desktop video-editing software to create videos specifically to use as

both take text and slice it sideways, so when the phone or tablet is moved through the scene the words are spelled out. It's not exactly high art but it's plenty of fun.

Dr.Light Painting allows up to 50 characters and a choice of text and background colours. There's a slider to set the speed of the animation, although a bit of trial and error is required to match this with the speed at which the device is moved through the scene. We couldn't turn off the onscreen Home, Back and Menu buttons on our Android phone, so text looks underlined, but overall this app did the job well.

Holographium is a bit more sophisticated, with the ability to create 3D text characters with a variable depth. It can also import photos to create an image that appears to be floating in mid-air. The best results come when the floating text interacts with the scene – something our Holographium example (opposite, top) doesn't really achieve. Making letters illuminate objects in the scene is one way to achieve this.

We hope you've found some inspiration in this article, but we're sure you'll be able to find your own spin on these techniques; the apps are inexpensive or free, so there's little to stop you experimenting. 📱

A video is a constantly evolving light source, and playing a video on a device that's moving through a scene can create rich, complex patterns

picking out the keyboard while keeping the rest of the piano in relative darkness. There's a range of coloured tints on the keys, depending on the dominant colour in the video at that particular moment. There are also a few wisps of light where the phone screen was pointing towards the camera, and where it reflected on the piano lid. Shooting in Raw mode and developing the image in Lightroom let us skew the colours to our liking with the white balance and saturation controls, manipulate the contrast and add a vignette to darken the edges of the frame.

a light source on an iPad. The image with a trail of light with regular bulges (opposite) was created with a video of a circle that grows and shrinks at regular intervals. There's also a regular undulation to the trail created by our footsteps. The result is a cross between blown glass and a snake after a large meal.

FLOATING TEXT

You can also use a phone or tablet to create text that appears to float. Holographium for iOS (£3.99, tinyurl.com/330holog) and Dr.Light Painting for Android (free, tinyurl.com/330drlight)

NEXT MONTH

DESIGN A WEBSITE

Create your own website using an iPad and the free Adobe Slate app

Zygote

Raising the decibel count to unbearable levels may be antisocial, but at least **Zygote** is able to find some inner peace after downloading a saintly new app

ON YOUR TODD

Official departments in Lincoln County, New Mexico, share a network that hosts all their files. Unfortunately, nobody trained any of their system operators to recognise a potential virus attack. Recently, a careless operator ran an executable file embedded in an email. As a result, the entire system was hijacked by malware, scrambling all the departmental files and then locking them down.

The criminals demanded \$300 in bitcoins, or they would wipe the files permanently. With no backup in place, and after failing to unlock the files themselves, the system owners paid up just before the deadline expired.

News of the hijack leaked to the press, and there were some very red faces when questions were asked about why the cops hadn't acted sooner. Sheriff Todd Brackett of Lincoln County Police mumbled, "We'll have more virus-protection training where we go over how to tell if something might be a virus. Or not." How profound. The hubs that had been hit were all four city police departments and the office of a certain Sheriff Todd Brackett.

SAINTS ALIVE

Mary Helen MacKillop was an Australian nun who bore a striking resemblance to the statuesque Hollywood star Kathleen Turner, although that's probably not the reason she has been canonised as Australia's first saint. Anyway, it is thanks to her that the Catholic Archdiocese of Adelaide is claiming the first ever blessing of an iPad. The sacred tablet runs a heavenly app to guide users along an urban path of enlightenment, which retraces Holy Mary's steps.

The blessing was given by the Vicar General, Father Philip Marshall, who stated: "The world God wants is one where we don't walk in shoes made by women coerced to work in sweatshops or where we buy chocolate eggs made from cocoa picked by child

slaves." Presumably he also wants a world free from the predatory child abuse which has been rife in his own diocese, and where his own archbishop is charged with covering up his church's involvement.

Zygote also notes that the saintly app runs on Android, but the Vicar General only sees Apples as fit for blessing.

'EAR 'EAR

As you'd expect, Zygote waded through every word of each of the political parties' recent manifestos, so you wouldn't have to. Buried in the 158-page Liberal Democrat document were the full details of their Freedoms Act, which would have decriminalised "insulting words, jokes and social media communications", thereby giving Zygote free rein to call Nick Clegg a poltroon without fear of repercussions.

There was another excellent pledge in the Freedoms Act, to "ban high-frequency Mosquito devices which discriminate against young people". The original Mosquitos were designed to disperse groups of youngsters from public spaces by blasting them with high-pitched sounds that only youthful ears can hear, four times a second, and limited to five decibels above the ambient noise level. But the latest Mark 4 Mosquito pumps

out audio deterrents at 100 decibels, which would cause dogs to cower and bats to explode. Zygote admits to downloading a little app which works in much the same way, and is useful when travelling by public transport.

Nothing quite compares to the owners of a car park in the Rockdale suburb of Sydney, though, to whom the council gave permission to blast Barry Manilow's Greatest Hits from loudspeakers, which instantly sent youths fleeing from the area. If only the Lib Dems had put that in their manifesto they would have been swept to power. And speaking of elections...

VIRGINIA PLAIN

The Virginia State Government has decided to shut down the electronic voting system in all 30 of its administrative counties, after admitting that hackers might be able to "modify the votes recorded by the devices in approximately 10 seconds". Their Wi-Fi connections were permanently on, each unit had an accessible USB port, most of them had never had their default passwords reset, and those that had been changed were ludicrously easy to guess.

The systems were running on state-of-the-ark unpatched Windows XP, and security warnings were first issued in

2004. The company that built them went bust in 2007 and other users, including the state of Pennsylvania, had slung their systems out in 2008 because of vulnerability to hackers.

Zygote wonders why it took the Virginians until April 2015 to recognise the problem and muses how many voters will be scrutinising the number of 'close' election results experienced over the past decade.

JUST IN CASE

Zygote wishes to congratulate Apple on producing a range of laptops designed to last forever and never ever go wrong. They must be everlasting, because the new Retina MacBooks are completely impossible to take to pieces and repair.

Their cases and keyboards are locked by 86 patented screws that even Doctor Who's sonic screwdriver could not undo. And even if he did manage to get the wondrous things open, all serviceable parts have been welded or superglued into place, including the RAM, the flash drive, the trackpad and the battery packs. Servicing, removal or replacement of these new MacBook innards are obviously completely unnecessary, and Zygote can't wait to invest a mere £1,999 in a 15in 2.5GHz model. And a hammer. ☹



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